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Hardware Virtualization for Low Cost Solutions in Education

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Abstract **– Currently, Virtualization Technology (VT) is one of the significant technology that provide maximum benefits and opportunities for computing industry, education and research. At present, mostly used and developed mechanism is hardware virtualization which provides a common platform to run multiple operating systems and applications in independent partitions. More precisely, the term 'hardware virtualization' is used abundantly throughout the education industry. However, Hardware virtualization for low cost solutions in education is just beginning to take advantage of VT. The work proposed in this paper focuses on the theoretical aspects and effective usage of hardware virtualization platforms based on several educational applications for low cost. This paper also reveals the features of virtualization technologies and discusses the consolidation of application-specific servers onto shared servers.**

Keywords **– Hardware Virtualization, VT, Server Virtualization, Hyper-V, Architecture.**

I. INTRODUCTION

From past few years, education industry has consecutive implementing virtualization technique. With the roots extending back to the several decades, the most common and continuously updated technology is virtualization. While moving in the beneficial direction, the fact remains that educational institute expecting more from the current technology than it frequently gets. Fortunately, advances in both the technology and the procedures employed to implement the technology may provide answers. While relatively new to educational institutes the concept of virtualization is proving itself in the business world as "the next big thing." Virtualization is a framework or methodology for hiding the physical characteristics of computing resources from the way in which other systems, applications or end users interact with those resources. The concept of virtualization is very broad and allowed multiple virtual machines with heterogeneous operating system to run side by side. While the details can be broad and abstract, Virtualization can play a very important role on education technology and provide benefits that are generally unobtainable without virtualization.

Hardware virtualization is an evolving technology that may become dominant, especially for server platforms, because it has the potential to facilitate the consolidation of multiple workloads on a single physical server. Hardware Virtualization can play an important part in tomorrow's education industry. Impact of virtualization on education technology is potentially significant, for example, using virtualization the overall costs can be reduced and operational efficiencies of educational institutes can be improved.

Precisely, virtualization is a methodology of dividing the assets of a computer into multiple accomplishment atmospheres, by applying one or more conception or technologies such as hardware and software separation, time-sharing, partial or complete machine imitation, emulation, quality of service, and many others. This can be applied by either software or hardware or both and also for Desktop computer as well as for the Server machine.

In software-only virtualization technique, a Virtual Machine Monitor (VMM) program is used to distribute resources to the current multiple threads. But this software-only virtualization solution has some limitations. One is allocation of memory space by guest operating systems where applications would conventionally run. Another problem is binary translation, i.e. the necessity of extra layer of communication for binary translation, in order to emulate the hardware environment by providing interfaces to physical resources such as processors, memory, storage, graphics cards, and network adapters [16]. So hardware virtualization technique is a good solution to face the above problems which works in cooperation with VMM. This virtualization technique provides a new architecture upon which the operating system can run directly, it removes the need for binary translation. Thus, increased performance and supportability ensured. It also enhances the reliability, supportability, security, and flexibility of virtualization solutions. So the keen interest is on hardware virtualization.

II. SERVER VIRTUALIZATION

A key benefit of virtualization technologies is server virtualization—the capability to virtualized server workloads. Server virtualization can save businesses money and simplify management overhead by allowing them to reduce the number of physical servers they need through server consolidation. Microsoft offers three business-level servers virtualization products. The first is Microsoft Hyper-V [4], a hardware-assisted virtualization server role that is available in Microsoft Windows Server 2008 R2. The second is Microsoft Hyper-V Server 2008 R2, a standalone hypervisor-based server virtualization product that lets businesses virtualize workloads onto a single physical server. And the third is Microsoft Virtual Server 2005 R2 SP1, a server virtualization product that runs on Windows Server 2003 or later and can use, but does not require, hardware-assisted virtualization.

The term Hardware Virtualization refers to ensuring that an IT infrastructure is available to users whenever it is needed. When multiple users require the same resource at the same time, some users may have to wait for access. The traditional way of addressing this issue is by adding servers to the infrastructure. Virtualization, running an application or server on hardware in the data center which is distributed to users on demand across the organization, is the solution to inefficient use of hardware assets. Hyper-V is an example of server (or machine) virtualization technology. Each guest operating system thinks (if operating systems could think) that it owns the computer and has exclusive use of the computer's hardware resources (or to whatever subset of the total machine resources that have been allocated to the virtual machine). Each operating system is therefore said to be running in a separate virtual machine, with these multiple virtual machines running on the same physical computer. In a typical nonvirtualized environment, only one operating system can run on a computer—it's Hyper-V that makes running multiple virtual machines possible.

III. UNDERSTANDING HYPER VISOR

A hypervisor is a virtualization platform that enables you to run multiple operating systems on a single physical computer called the host computer. The main function of the hypervisor is to provide isolated execution environments for each virtual machine and to manage access between the guest operating systems running in virtual machines and the underlying hardware resources on the physical computer. The creation of the hypervisor was a milestone in the evolution of computing because it provided a way to overcome the architectural limitations and high cost of using mainframe computers. The job of the hypervisor is to control processor, memory and other firmware resources. The hypervisor acts like a traffic cop, allowing multiple operating systems to run on the same device without requiring source code or binary changes. Each operating system appears to have the processor, memory, and other firmware resources all to itself -- but in reality, the hypervisor is controlling the processor and its resources, allocating what is needed to each operating system in turn.

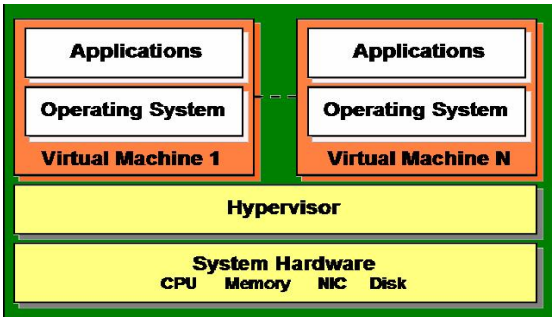

Fig.1. shows the basic functioning of hyper visor

Hyper-V Architecture

Hyper-V supports confinement in terms of a *partition*. A partition is a logical unit of confinement, supported by the hypervisor, in which operating systems execute. A hypervisor instance has to have at least one *parent partition*, running Windows Server 2008. The virtualization stack runs in the parent partition and has direct access to the hardware devices. The parent partition then creates the *child partitions* which host the guest OSs. A parent partition creates child partitions using the *hypercall* API, which is the application programming interface exposed by Hyper-V.

A virtualized partition does not have acceptance to the physical processor, nor does it handle its real interrupts. Instead, it has a virtual view of the processor and runs in *Guest Virtual Address*, which, depending on the configuration of the hypervisor, might not necessarily be the entire virtual address space. A hypervisor could choose to expose only a subset of the processors to each partition. The hypervisor handles the interrupts to the processor, and redirects them to the respective partition using a logical *Synthetic Interrupt Controller* (SynIC). Hyper-V can hardware accelerate the address translation of Guest Virtual Address-spaces by using second level address translation provided by the CPU. Child partitions do not have direct access to hardware resources, but instead have a virtual view of the resources, in terms of *virtual devices*. Any request to the virtual devices is redirected via the *VMBus* to the devices in the parent partition, which will manage the requests. The VMBus is a logical channel which enables inter-partition communication. The response is also redirected via the VMBus. If the devices in the parent partition are also virtual devices, it will be redirected further until it reaches the parent partition, where it will gain access to the physical devices. Parent partitions run a *Virtualization Service Provider* (VSP), which connects to the VMBus and handles device access requests from child partitions. Child partition virtual devices internally run a *Virtualization Service Client* (VSC), which redirect the request to VSPs in the parent partition via the VMBus. This entire process is transparent to the guest OS. Virtual devices can also take advantage of a Windows Server Virtualization feature, named *Enlightened I/O*, for storage, networking and graphics subsystems, among others. Enlightened I/O is specialized virtualization-aware implementation of high level communication protocols like SCSI to take advantage of VMBus directly, that allows bypassing any device emulation layer. This makes the communication more efficient, but requires the guest OS to support Enlightened I/O. Windows Server 2008 R2, Windows Server 2008, Windows 7, Windows Vista, Red Hat Enterprise Linux, and SUSE Linux are currently the only operating systems that support Enlightened I/O, allowing them therefore to run faster as guest operating systems under Hyper-V than other operating systems that need to use slower emulated hardware.

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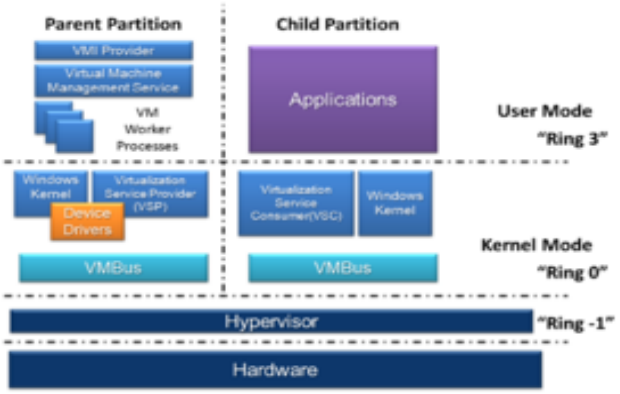

Fig.2. shows the archietecture of Hyper-V

IV. Necessity of Server Virtualization for Education

Server virtualization is not a new concept. There are different levels of virtualization which we are used earlier like, An operating system support a virtual view of a machine to the processes running on it, their resources are virtualized. Each process takes a virtual address space. A process approach is the allowance of control what files it can access. This is the storage virtualization. The scheduler virtualizes the CPU so that multiple processes can run without interfering with each other. Similarly, Network is also virtualized by providing multiple streams over the same physical link. Today, the term "server virtualization" means running multiple operating system on one physical machine. This is just the adding one more level of virtualization. An additional level generally means added costs, lower performance, and higher maintenance. Server virtualization enumerates the drivers for running multiple operating systems on one physical machine. Many educational institutes budget meant that it was on a five-year refresh cycle, and some of its PCs were actually eight years old. We needed a tool for efficiently and cost-effectively migrate and support refresh cycles that included constant improvements and renovates in education industry. It sought a solution that would provide students with access to exclusive technology while lowering costs and streamlining implementation and maintenance, without compromising on security. It also required a stable platform that would meet students' needs today yet easily expand in the future. Server virtualization is a "heavy" solution for the problems, addresses today in education industry.

A. Going Green with virtualization

Higher education leaders realize that green practices not only help the environment, but can go a long way in helping them operate their campuses more efficiently and cost-effectively. According to the strategy paper from Centre for Digital Education nationally, over 500 colleges and universities have institution wide sustainability or environmental committees and 300 campuses have conducted campus sustainability assessments, with hundreds more working to implement assessments [5]. Colleges and universities are demonstrating their dedication to environmentally sound practices and serving as an example to the private sector and the general public. In order to save money on facilities, power, cooling, and hardware, analysts say moving to a virtual data center is a first fundamental step. By applying the earliest processing power of today's high-power servers and storage devices, we can transfer the improved performance with reduced operating expenses, a smaller data center footprint, and significantly curtailed greenhouse gas emissions. Many organizations have utilized virtualization to avoid building new data centers and to shrink the footprint of their existing data centers by up to 60%. Virtualized environments allow enhanced backup and data recovery operations by assist the progress of automated failover. These environments can also help speed development efforts by making it easier to bring up development servers though the use of template-driven provisioning.

B. The Value of Virtualization in Education

The value of virtualization for higher institutions across the country helps reliable way and effective computing options. Superiors have multiple choices available to meet student requests, but the cost of the technology itself combined with the need for a robust infrastructure to support it and dedicated personnel to manage it — can be excessive. The Hardware virtualization solution with Hypervisor enables educational institutes to consolidate server resources, to improve utilization, reduce data centre floor space requirements, and cut power and cooling costs. Virtualization ensures remote access to education institute's resources for students. Using virtualization, students can access resources from various devices – mobiles, game consoles, desktops, notebooks, etc. Network security also provided by virtualization helps education institutes to allow connections to various devices from different locations without compromising on the security of educational institute's network.

C. Why Virtualize?

There are many reasons for adopting server virtualization. A popular one is better resource utilization. It is not uncommon to see servers running at 10 percent or less of their capacity, at different points in the day. By letting several virtual servers share a single set of hardware, a much higher average utilization rate is achieved, and hardware and support costs are lowered. Virtualization also makes it easier to provision and reallocate servers. Instead of having to manually set up a server, the virtualization software can set up a server using a pre-existing template and shift server images from one physical server to another to balance workloads or improve efficiency. It can also automatically set up a new virtual server on a different machine when there is a hardware malfunction. Each application is isolated from the others, which provides greater security.

VMM has the following additional capabilities.

- It can handle multiple Guest Operating Systems.
- It creates multiple Virtual Machines each of which runs different Guest Operating Systems.
- It has the functionality to schedule the guests one after the other in a Round Robin fashion.

V. Related Work

A recent study that surveyed Chief Information Officers (CIOs) indicated that more than one third of respondents identified server, storage, and cloud virtualization as drivers of their spending decisions for 2009 and 2010, and almost one quarter of respondents also identified desktop virtualization as similar drivers [4]. The University of Utah's Health Sciences Center used HP Services consulting to virtualize their server infrastructure on a 10 VM to 1 physical server. As with most sever virtualization projects, power and cooling costs are reduced because of the reduced number of physical servers that are required [8]. San Jose State University's implementation of a virtual infrastructure resulted in six virtual machines per physical server and Other benefits cited included faster server deployment, system stability, disaster recovery and improved server management capabilities (VMWare, 2005) [11]. Microsoft provides with the most comprehensive set of technologies to evolve your datacenter over time. Whether you want to virtualize, build a private cloud, scale your services through a public cloud, or have a mix of all three, Microsoft datacenter solutions can help us better manage your datacenter today and accelerate your journey towards cloud computing [10]. The study indicated by Mitch Tulloch is that, virtualization would influence their spending decisions more than issues such as labor optimization, wireless computing, Green computing, or security concerns. As a result of these concerns, this study investigating how Microsoft virtualization platforms, products, and solutions can help them address their concerns. In other words, more businesses than ever are aligning themselves with Dynamic IT, Microsoft's strategic vision for implementing IT infrastructures that can automatically adjust to changing business conditions by aligning computing resources with business objectives[3].

VI. Proposed Work

This paper comes up with the concept of Hardware virtualization with Microsoft Hyper-V for increased system reliability and low cost solutions in education. The Educational Institutes has running too many applications on one server and then concern why the things didn't work properly. But in the Virtualized environment, each application runs in its own secure environment. It's been a real advantage for us. By abstraction of the applications on dedicated virtual machines, the machine's available resources become the factor limiting the number of applications that can be supported, instead of the complexity of supporting multiple applications that share a single operating system environment. Virtualization is green. As schools/colleges alter older desktop PCs with hardware precisely designed as thin clients, there are expressive savings determined from reduced power consumption. Server Virtualization can help us to meet our entire requirement for facilitate server consolidation and management, and enhancing user productivity. It transforms operating systems into centrally managed services that are available whenever and wherever needed. The proposed work signifies the importance of Hardware virtualization to efficiently use Server resources in order to reduce the total number of servers or server locations to maximize the hardware utilization.

VII. Brief Comparison of Features between VMW are and Hyper-V

With Microsoft's Hyper-V we can consolidate many servers to fewer physical servers without compromising on services. Hyper-V allows for the consolidation of multiple server instances as separate virtual machines running on a single physical machine (the Virtualization Host). So Microsoft has made great improvements to Hyper-V and with the latest release (2008 R2 SP1) has added many features that can be found in VMware. According to Chris Childerhose, a consultant and MCITP with a local Microsoft Partner briefly describe how Hyper-V compares to VMware [18]. This list outlines many of them:

Feature	V Sphere 4.1	Hyper-V 2008 R2
Bare-metal Hypervisor	ESX/ESXi	Hyper-V
Centralized Hypervisor Management	Virtual Center Server	System Center Virtual Machine Manag
cross-platform hypervisor management	None	System Center Virtual Machine Manager
virtual machine backup	VCB or 3rd party products	Windows Server Backup, System Center Data Protection Manager, or 3rd party products
High Availability / Failover	(Via Virtual Center Server)	Failover Cluster Manager
VM Migration	vMotion (Via Virtual Center Server, Enterprise Plus)	Live Migration
Storage Live Migration	(Via Virtual Center Server, Enterprise Plus)	No
Guest OS patching/management	(Via Virtual Center Server – not in next version)	Windows Server Update Services (WSUS)
End-to-end OS monitoring	None	(via System Center Operations Manager)
Host/VM level optimization	DRS (Via Virtual Center Server, Enterprise Plus)	PRO (via System Center Operations Manager)
Application/service monitoring	None	PRO (via System Center Operations Manager)

Integrated physical and virtual management	None	System Center Virtual Machine Manager 2012, System Center Configuration Manager

VIII. Conclusions and Future Work

This paper aims to focus on Hardware Virtualization that separately delivers a high performance solution at the lowest cost. In addition, this technology accommodate with other technologies such as machine virtualization to solve business, and data centre problems. Any institution responsible for more than one PC should seriously consider the advantages of moving to Hardware virtualization. By taking improvement of today's low-cost yet ever-more-powerful computers, even the smallest institution can realize immediate benefits without the high expense of mainframe estimating or the complexity and performance limitations of server-based estimating. Best of all, Hardware virtualization makes computing available to more people within your institution for less money. Virtualization Technology is not a new concept. It's been around since the 1970's when mainframe computers were running multiple instances of an operating system. But the mainframe market was decimated by the introduction of low cost personal computers and along with it went VT. As time went on advances in personal computer hardware and software allowed the re-introduction of virtualization technology to the market. Today's computer hardware has become so powerful that many computing resources go underutilized. The main motive behind the proposed work is to leverage this underutilization while saving on hardware resources. Clearly, institutions across the world are leveraging virtualization technology to improve their bottom line while improving operations. With new quad-core processors and 64-bit operating systems this trend can only continue to increase. Hardware Virtualization is still at an emerging stage. Further improvement can be made by implementing this technology and provide effective results for reducing the server workloads and cost in education's world.

References

[1] White Paper Intel® Core™ vPro™ Processors Emerging ComputeModels:"*UnderstandingDesktopVirtualization"*.Availa ble:*http*://www.intel.com/content/dam/doc/whitepaper/virtualizat ion-understanding-desktop-virtualization-paper.pdf.

[2] IBM Global Education White Paper," *Virtualization in Education"*, October 2007.

[3] Mitch Tulloch," Understanding Microsoft Virtualization Solutions from the Desktop to the *Datacenter, 2nd Edition"*, a Division of Microsoft Corporation in Washington 2010.

[4] W. Fuertes, J. E. López de Vergara2, F. Meneses," *Education Platform Using Virtualization Techniques"*, August 2009

[5] A strategy paper from Centre for Digital Education," *Desktop Virtualization in Higher Education"*, October 2009.

[6] A Customer Case study on Cisco systems on," *Washington Schools Implement Desktop Virtualization Solution"*, 2010.

[7] Bowdoin, *Datacenter Consolidation and Virtualization*, from BowdoinCollege,March182008,Available:http://www.bowdoin.edu/it/highlightedprojects/infrastructure/datacenter_consolidation_and_vi.shtml.

[8] Palo Alto CA: HP. Hewlett Packard "*Virtualization enables 10:1 server consolidation at regional health center"*, 2006

[9] Microsoft Server and Cloud Platform," *Datacenter Virtualization &Management"*,Available:http://www.microsoft.com/enus/servercloud/datacenter/virtualization.aspx.

[10] Palo Alto, CA, VMWare,"*San Jose University's Virtual Infrastructure Ensures Availability Of Computing Resource Even With Budget Cuts"*. 2005.

[11] Narendra Ku. Tyagi, " *Virtualization of Database Layer"*, Global Journal of Enterprise Information System, January 2009.

[12] Singh, Amit"*An Introduction to Virtualization."* Retrieved March 14, 2005.

[13] Yager, Tom, *"The reality of virtual servers. Infoworld."* April 15, 2005.

[14] C S Shyam Sundar, *"Virtualization: A Resource-maximizing technology with Security Benefits.*

[15] Brandel, Mary, *"Wired over server virtualization. Network World Fusion"*. March 24, 2005.

[16] Connor, Deni, *"Welch's reaps benefits from server virtualization"* April 15, 2005

[17] Lindstrom, Pete *"Security That's Virtually There. Information Security"*, April 20, 2005

[18] Chris Childerhose,Blogging article on," *Brief comaprison between VMWare and Hyper-V"*, Available : http://garvis.ca/2011/06/10/a-brief-comparison-of-features-between-vmware-and-hyper-v-guest-blogger/ ,June 10 2011

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