SERVER VIRTUALIZATION: A COST EFFECTIVE AND GREEN COMPUTING APPROACH TOWARDS EDUCATIONAL INFRASTRUCTURE MANAGEMENT

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Abstract: Educational Infrastructure Management is a costly affair. Libraries, Computer centers and laboratories, classrooms, Internet services, campus wide network are the basic infrastructure of any educational organization. Frequent replacements, upgradeation of the hardware, software in computer related infrastructure is often. Many courses in the computing curriculum can benefit from hands-on educational activities in the form of laboratory components associated with the lectures [11]. Over the past years, many problems related to the system administration of laboratories for system-oriented courses have found well-designed solutions in the deployment of virtualization suites [12]. This technological advance enabled these courses to switch from a mostly descriptive content to learning activities which engage students in hands-on, authentic, problem-based learning. Operating systems, system administration and networking are all examples of laboratories for which students need root access to be able to experiment with the concepts and implementation studied in the lectures [10]. With this constraint comes the need for a more flexible classroom management strategy. This paper explores how some open source virtualization and clustering technologies can be deployed to provide students, as well as instructors, with such an environment. We focus on providing solutions which can integrate transparently to any campus without involving significant changes to the classroom computers. We also emphasize the scalability aspect by providing a highly cost-effective solution which can be easily scaled up as the number of students or the requirements of the course in terms of computational power increase. Virtualization is also seen as one of the Green ITs which can help reduce infrastructure and maintenance cost especially for the organizations that may not be able to afford big capital investment upfront [13]. Virtualization also eliminates the need to maintain and manage large, expensive systems across several campuses, giving colleges and universities a scalable, cost-effective solution that supports next-generation learning, assessment, and development [14].

Keywords: Educational Infrastructure, Virtualization, Virtual Machines, Green IT, Open Source, Clustering.

I. INTRODUCTION:

As the global financial turmoil highlights the increasing costs associated with creating and supporting computer hardware and the space it occupies, servers in the Educational Infrastructure management are attracting attention [8]. Providing IT infrastructure in colleges for building server complex topics like cloud, virtualization is a very costly proposal. However such facilities are a necessity nowadays [1,2]. It is an important aspect of educational infrastructural management.

In this paper we present how the cost effective approach to educational infrastructure management can be achieved using VMware Server Technology. VMware Server virtualization is a proven, stable technology that directly reduces risk and increases available computing capacity while simultaneously reducing energy consumption when properly deployed [9]. Administrators must constantly re-evaluate and assess their strategies for cost reduction, efficiencies, business agility, faster deployment, and disaster recovery and business continuity.

We have used VMware Server Virtualization which will monitor as well as administrate the virtual machines running on various nodes. Virtualization offers a first-step solution to the cost equation that arises when technology contends with space and other resources [8]. In this paper, server virtualization is proposed as a remedy to infrastructure demands and also an attempt is made to evaluate virtualization educational infrastructural management domain, with a particular emphasis on how new virtualization technologies can be used to simplify deployment, improve resource efficiency, and reduce the cost of reliability.

II. EDUCATIONAL INFRASTRUCTURE MANAGEMENT CHALLENGES

KHMELEVSKY and VOYTENKO [2] have emphasized this aspect in one of their articles on university educational infrastructures. First question that may be asked is, do the college labs have basic resources in their labs which can be used to build such sophisticated infrastructure. The answer is yes. Over the years desktops have become quite powerful. Modern computers, even the desktops used in college laboratories, are sufficiently powerful now to support virtualization, and present the illusion of many smaller virtual machines (VMs) running within, with each node using a separate operating system instance [3][4]. Server virtualization is becoming a mainstream solution in the Educational Infrastructure Management. Cost of hardware and the cost of staff
to support numerous servers in an Educational Infrastructure Management are primary reasons for early adopters to move to server virtualization. Additional benefits included the reduction of physical Educational Infrastructure Management space for the proliferation of servers. “Greening of IT” grew in importance as the benefit of reduced power consumption has been documented as a long-term operating expense reduction. Server virtualization is now a mainstream IT activity as server virtualization has matured and the economy acts as reinforcement to reduce operating expenses. Desktop virtualization is being researched as a way to streamline delivery of instructional desktop configurations. Implementing Server Virtualization in labs, staff time between semesters can be reduced by deploying desktop virtualization. Recovery time of a corrupted desktop will also be reduced thus minimizing the impact in the classroom when software problems occur [5].

III. **IT FINANCIAL MANAGEMENT FOR VIRTUALIZATION**

While the cost of hardware had decreased significantly, servers, storage, and desktop computers still remain very large budget items for Educational IT. Complete and ongoing cost visibility into these complex cost drivers is vital for virtualization and consolidation strategies designed to save money while aligning with Educational goals. [7]

Get the Highest Value from Virtualization and Consolidation Virtualization and consolidation can save money in many areas: hardware, administration, energy, support, and more. The management should consider following aspects before going for virtualization, these are location specific:

- Which servers are the best candidates for virtualization or consolidation?
- Where should we start with virtualization to give the biggest cost benefit?
- Where can we consolidate without impacting the business?
- Did we get the desired benefit? If not how can we improve?

**Prioritize Server Consolidation** :- By delivering visibility into server utilization and cost, our IT Financial Management solution can immediately identify the servers that are the best candidates to deliver significant costs savings through consolidation.

**Identify Candidates for Storage Tiering** - Our IT Financial Management solution can immediately identify storage that has both low utilization and high costs. This will identify the types of storage that are most likely to deliver significant cost savings without impacting business results if storage tiering is used. [7]

IV. **THE NEED FOR SERVER VIRTUALIZATION**

The Educational Infrastructure system in the current period consists of centralized system i.e. the Client Server system, in which there are multiple clients connected to the server. In this centralized system the server and clients are having their independent physical machine with their resources i.e. motherboard, processor, memory, hard disk, etc as shown in below figure. The utilization of these resources is not up to the optimal used, due to which the need for server virtualization rises. By using server virtualization we can utilize the resources up to the maximum use. So these unutilized resources are used by server virtualization by creating multiple Virtual Machines (VM) on the physical machines as shown in below figure. In this way the cost of the Hardware as well as software can be reduced up to maximum by demanding server virtualization.

In the current study server virtualization was created by using VMware Server Software application. The software application is open source. The prototype was implemented at the MCA Department of AIMS.

**Figure1. Virtual Machine**

Available hypervisors permit multiple operating systems instances to run concurrently within virtual machines (VMs) on a single physical machine, dynamically partitioning and sharing the available physical resources such as CPU, storage, memory, and I/O devices. In this architecture, hypervisor is responsible for running multiple operating systems’ images and all associated applications to share the resources of a single hardware machine. It makes certain that hardware resources, such as CPU, memory, I/O, etc, are properly and securely partitioned among different operating systems’ images and their applications. Applications running in each virtual machine are protected as if they were installed on independent physical machines [6].
V. ESTIMATE OF COST SAVING:

Our experience indicates that (Table.1) the cost can be reduced in the range of 45-47% over the cost of new infrastructure if one follows a proper indigenous design. Implementing of this Server Virtualization in all labs would be the next plan, which will allow the management to scale up the benefits to a significant extent. Currently we have already used the setups in supplementary the teaching in few courses which are offered to MCA, MCM students as pilot study.

Table 1: The Cost Estimates (approximated and based on current quotations in thousands Rupees)

<table>
<thead>
<tr>
<th>Components</th>
<th>Non Server Virtualized Systems</th>
<th>Server Virtualized Systems</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Particulars</td>
<td>Cost</td>
</tr>
<tr>
<td>CPU</td>
<td>Intel Core I3 (64 Bit)</td>
<td>13.5-15</td>
</tr>
<tr>
<td>Mother Board</td>
<td>Intel Chipset</td>
<td></td>
</tr>
<tr>
<td>Cache memory</td>
<td>4 MB</td>
<td></td>
</tr>
<tr>
<td>RAM</td>
<td>2GB (DDR3)</td>
<td></td>
</tr>
<tr>
<td>Hard Disk</td>
<td>SATA-300 (320GB)</td>
<td></td>
</tr>
<tr>
<td>Virtualization Technology Card</td>
<td>Present on motherboard</td>
<td></td>
</tr>
<tr>
<td>Ethernet Port</td>
<td>Gigabit Ethernet(10000MBPS)</td>
<td></td>
</tr>
<tr>
<td>Monitor (LCD)</td>
<td>Acer 18.5”</td>
<td>9-10</td>
</tr>
</tbody>
</table>
Software | Operating System 1 | Windows XP SP3 | 5-7 | 4 | Linux (CentOS 6, Fedora 17) For 64 Bit system | Open source | 1
---|---|---|---|---|---|---|---
| Operating System 2 | Linux (CentOS6, Fedora17) For 32 Bit system | Open source | 1
| Hypervisor | - | - | VMware | Open source | 1
| Guest Operating System-1 | - | - | Linux (CentOS 6, Fedora 17) | Open source | 1
| Guest Operating System-2 | - | - | Windows XP sp3 | 5-7 | 1
| N Computing Device | - | - | X300 (1 server+ 3 Thin Client) | 3.5 | 1
| Miscellaneous cost | - | 1 | 4 | - | 1 | 4
| Total cost in Thousand Rs. | - | 114-132 | - | 62-69.5

In words: One lakh fourteen thousand-One lakh thirty two thousand rupees. Sixty two thousand-Sixty nine thousand five hundred rupees.

Table 2: Infrastructure wise Physical Machine

<table>
<thead>
<tr>
<th>Infrastructure</th>
<th>No. of Machine</th>
<th>Electricity consumption (In Watts per hour)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non Virtualization</td>
<td>250</td>
<td>21000</td>
</tr>
<tr>
<td>Virtualization</td>
<td>63</td>
<td>8471</td>
</tr>
</tbody>
</table>

Graph 1: Infrastructure wise Physical Machine and Electricity consumption (In Watts) for 1 Hour

The above graph 1A shows Infrastructure wise Physical Machine usage with 75% reduction in the overall infrastructure. The above graph 1B shows the infrastructure wise Electricity consumption in watts. Total watts required for 1 physical machine with LCD screen is about 84 watts per hour. Therefore the total watts required for 250 machines=21000 watts in non server virtualization environment and 8471 watts for (63 machines+ 187 LCD Screen). It concludes that we can save 60% electricity consumption and it is one of the Green ITs which can help reduce infrastructure and maintenance cost.

CONCLUDING REMARKS

VMware provides an excellent platform for deployment and VMM of Server Virtualization. Academic Institutions can take benefit of this platform for use in Laboratory to provide cost effective solutions.
The infrastructure created can also be intelligently used for teaching networking concepts to students with the tremendous advantage of having everything at one place. Providing a good platform where algorithms on parallel computing, distributed computing can be tested is a necessity, which can be met with this type of infra-structure. The future research work in Server Virtualization will be carried in private cloud building and its virtual clustering.

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