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Virtualization Technology Literature Review

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Abstract - Trends in virtualization are always changing. As the technology matures and advances are made, there are more options open to administrators and more cost saving virtualization projects that can be implemented. The websites and articles listed in the reference section, give you some idea of the capability using the VMWare product, which is simply one of several virtualization options. Any company currently using physical servers can benefit from the cost savings and management simplification of a virtualized server environment. Virtualization allows for the maximizing of hardware through the sharing of resources. A virtualized environment is also easier to backup and restore for disaster recovery purposes. ESXi is a free product, and virtualization can often be achieved on existing hardware. The purpose of this review is to look at virtualization from the perspective of scholarly writers, but also understand how to implement a virtual environment that addresses the high cost of physical servers and rack space and can be implemented with very few tem members. This also addresses the ability of virtual environments to minimize downtime and simplify management. As for the need, all companies have a need to reduce costs and increase efficiency, and this type of project has a high ROI in both areas. This project will include research into the latest trends in virtualization. This has a direct application to business, strategic planning, and IT in general since this technology is rapidly permeating through the environments of IT departments and businesses around the world. Much scholarly work has also been done into the concept of virtualization, the impact on business in terms of ROI, disaster recovery, and reduced administration as well as the future of the technology in general.

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I. The History, Current Usage, and Future of Virtualization

Trends in virtualization are always changing. As the technology matures and advances are made, there are more options open to administrators and more cost saving virtualization projects that can be implemented. The website "Virtualize Your IT Infrastructure" by the VMWare Company gives you some idea of the capability using the VMWare product, which is simply one of several virtualization options. When compared with other hypervisors like Hyper V, or KVM, the features of VMWare's ESX and ESXi stand out. (Virtualize Your IT Infrastructure, 2012). A complete overview of the VMWare products and how they are applicable to each stage in the virtualization process is given, and also the various options or platforms for virtualization with each product. I will use this reference for the sections of the outline that directly relate to VMware and its capability and history. I also plan to cover other hypervisors, such as Microsoft's Hyper-V or the open source KVM platform, VMWare, and more specifically the ESX and ESXi platforms are the current standard to which the others are measured.

Connor (2004) makes the point that server virtualization is moving from small markets to the mainstream and that the rate of implementation is steadily increasing. The article also addresses the race to keep up with processor technology by VMWare and others (Connor, 2004). As evidence for this, Connor (2004) says, "If you look at processor trends, both Intel and AMD have shifted from increasing the clock speed of their processors to, increasing the number of processor cores on a single chip," says Michael Mullaney, vice president of marketing for VMware. "Going forward, you are going to find out that even a two-CPU server actually has four processors" (p. 01) Connor (2004) says "Virtualization is moving from a niche market into the mainstream, especially since Microsoft entered the market" (p. 01) This makes it clear that this is a project topic that is worth pursuing. This is a technology that is just now permeating into the main stream and the future of the technology is leading in a direction of more and more implementation. This article is very relevant to my project topic because of the statement above and the varied range of topics discussed in the article like VMWare's partnerships with Citrix, Dell, HP, IBM, Oracle and Red Hat.

Spiegel (2006) makes the case that there is business benefits in application and server virtualization, "Application virtualization is the new fancy trendy name for server-based computing. However, instead of installing applications on desktops, the applications are installed in a server farm for secure, remote access. Server virtualization allows you to take multiple physical servers and create the same number of virtual servers, or "machines," on one host physical server" (p. 01). By simplifying the structure and management, the business gets a benefit, or multiple benefits (Spiegel, 2006) This too supports the assertion that there is a business benefit to application and server virtualization. This assertion is further supported by the point that centralizing servers and application onto hypervisors, or rather servers running a virtual server product, like VMWare's ESXi, can give the business several things that add value and support the ROI. Those things being; reduced maintenance costs, reduced hardware costs, reduced licensing cost, reduced administration costs, and increased disaster recovery security.

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Hassell (2007) gives us a summary of his article in the abstract section when he says, “Virtualization, the move from real, physical hardware to virtual hardware is being seen as one of the "next big things" in IT. There are more virtualization options for IT departments than ever before, including XenSource Inc's and Virtual Iron Software Inc's open-source applications, Microsoft Corp's Virtual Server and VMware Inc's venerable products. But if you are new to this party, you might not know how to get started.” (p. 01). Hassell (2007) gives a broad overview of the topic and a launching point to explore the topic of virtualization and some of the options that are available, phases of implementation. (Hassell, 2007). Hassell (2007) is experienced in this field and is therefore a valued source for this subject matter. Hassell (2007) breaks down the process step by step, “The first step in virtualization is determining if you have the right type of infrastructure to support it. Look for a lot of machines doing similar tasks, and make sure you have more than 10 of them. For 10 or fewer, the payoff is questionable.” (p. 01).

Reducing redundant hardware through virtualization as a strategy is the key point made by McAllister (2007). McAllister (2007) states, “In today's complex IT environments, server virtualization simply makes sense. Redundant server hardware can rapidly fill enterprise datacenters to capacity; each new purchase drives up power and cooling costs even as it saps the bottom line. With virtualization, you can dynamically fire up and take down virtual servers, each of which basically fools an operating system into thinking the virtual machine is actual hardware. The most popular method of virtualization uses software called a hypervisor to create a layer of abstraction between virtual servers and the underlying hardware.” (p. 01). This is a valid statement, and the core idea of the process behind virtualization. This article also compares the state of virtualization now with the past and names the major players in the environment like VMWare and Microsoft (McAllister, 2007). McAllister (2007) validates not only one of my suggested methods of business benefit, which is cost savings, but it also provides context for the history and installation options of a virtual environment. McAllister (2007) also details many options that are available to administrators. One main point that is important to present is the time saving and options that are available to server administrators.

Bele and Desai (2012) look at virtualization from a slightly broader perspective. Beyond the hypervisor platform alone, Bele and Desai (2012) look at how virtual host tie into the rest of your environment, like SAN with a look at storage virtualization. Bele and Desai (2012) detail how all of these components are related, “Server Virtualization plays key role to resolve such problems. It abstracts the resources from the applications that utilize them and can be applied to many platforms. Virtualization Technology has been adopted at large level by many data centers in the industry. It provides benefits like server consolidation, live migration, data security, less power consumption etc. Same time Storage Virtualization abstracts physical storage (SAN, NAS) resources from front end applications running in the system. Storage virtualization is useful to maintain large volume of data with continuous backup facility” (p. 01). Bele and Desai (2012) look at the idea or concept of virtualization beyond mere server virtualization and gives us other lines to explore when looking at the value of virtualization on the whole. Any technology that really permeates the market typically is able to perform multiple functions, but is usually part of a larger technology.

Schultz (2009) looks at the beginnings, present, and future of virtualization. Schultz (2009) gives this insight, "With information virtualization, an enterprise is able to assemble a single view, or profile, of a client by bringing together information stored in multiple repositories. Virtualizing the workspace is the next logical step, Bishop says. While leading edge enterprises are striving toward this virtual nirvana, the majority of companies are baby-stepping their way through current-generation virtualization projects. What's next for them is more about growing the virtual server environment, integrating virtualization across servers, storage and the network, extending virtualization to the desktop" (p. 01). Schultz (2009) shows some of the changes in virtualization technology in the past and is key to my report by helping to detail and shape the "where did we come from" perspective. However, Schultz (2009) also gives a sense of where we are going with the technology, specifically the subject of desktop virtualization.

Norall (2007) gives this insight on the potential and advantages of storage virtualization, "In addition to creating storage pools composed of physical disks from different arrays, storage virtualization provides a wide range of services, delivered in a consistent way. These stretch from basic volume management, including LUN masking, concatenation, and volume grouping and striping, to data protection and disaster recovery functionality, including snapshots and mirroring. In short, virtualization solutions can be used as a central control point for enforcing storage management policies and achieving higher SLAs." (p. 01). As with other aspects of virtualization, Norall (2007) makes the point that there are clear advantages to virtualizing your storage. Norall (2007) shows that virtualization as a technology encompasses more than just server virtualization, which is the most common modern use of the overall technology. However, Norall (2007) shows that there are many aspects of virtualization and that it can be applied to many different technologies within the computer science spectrum.

Peggy (2007) makes the connection between virtualization and cost savings as follows: "There are three key areas of potential benefits: space, time and money. Fewer systems deployed results in lower capital costs. If companies can put 10 applications on 10 machines onto one or two machines, not only is that less money spent on computers, but the amount of money spent on electricity to power and cool these boxes goes down, freeing up precious data center space as well." (p. 01). Peggy (2007) discusses lowering costs through virtualization, which is one of the main advantages of virtualization.

Kontzer (2010) details a history and projected future for the technology, "More than a decade after VMware introduced the first software that enabled x86 virtualization, the question facing most IT executives is no longer whether they plan to virtualize, but how far they plan to go...The long-term potential of virtualization speaks to an issue that transcends server spread, budget concerns and any other barriers that might get in the way of a virtualization investment: The exponential growth of data is causing IT environments to burst at the seams." (p. 01). Kontzer (2010) explores not only the origin of the adoption of virtualization, but also the growth of virtualization in the industry, and what factors influence a company to make the investment in virtualization technology.

Kovar (2008) reveals the research that shows the current growth pattern of the virtualization technology. Kovar (2008) writes, "Solution providers are turning server virtualization, one of the fastest-growing segments of the IT market, into their very own gravy train. According to two recent exclusive CMP Channel surveys, solution providers said server virtualization is becoming a larger part of their business and it's also quickly becoming the catalyst for a wide range of other service offerings, including disaster recovery and data center consolidation." (p. 01). Everyone is talking about virtualization and just how hot it is, but can that growth or interest be measured? Yes, and Kovar (2008) shows that measurement and quantifies the growth factor.

Yoshida (2008) make the following revelation about storage virtualization," The initial approach to storage virtualization was to address virtualization in the storage-area network (SAN) because the SAN sat between the storage and servers and would cause the least disruption to these systems. However, after nearly a decade, this approach has not taken off while server virtualization has become widely accepted. The breakthrough came with the ability to virtualize physical logical unit numbers (LUNs) without the need to remap them by using a virtualization technique based on storage control units. This approach to storage virtualization is simple to implement. Storage virtualization will deliver significant efficiencies, cost savings, power and cooling benefits, as well as greater agility in aligning storage infrastructure to business requirements." (p. 01). One of the aspects of Yoshida's (2008) insight is to show that virtualization as a technology extends well beyond simple server virtualization.

Dubie (2009) goes deep into the concept and value of desktop virtualization, "Successful server virtualization deployments lead many IT managers to believe desktop virtualization would provide the same benefits. While that is partly true, companies need to be aware of how the two technologies differ" (p. 01). Dubie (2009) rightly points out that desktop virtualization is a technology not to be thought out lightly. Many industry experts focus on server virtualization, but Dubie (2009) suggests that desktop virtualization is the next big movement for virtualization. Dubie (2009) delves deep into the concept of desktop virtualization and reveals it to be a valid path for the mainstream IT department to pursue, but with caution and understanding.

Kennedy (2007) offers real solutions to the issue of desktop deployment, "Despite rumors to the contrary, virtualization is not just for the datacenter. From the most complex workstation applications to the simplest DLLs, virtualization is leaving an indelible mark on client computing. The idea behind application virtualization is to eliminate many of the support-draining configuration problems that plague conventional desktop implementations." (p.01) Kennedy (2007) takes on desktop virtualization from a slightly different perspective. Kennedy (2007) makes the point that desktop virtualization will continue to grow in the future.

Hsieh (2008) lays out a strategy that is key to any virtualization project, as follows, "Virtualization has become one of the hottest information technologies in the past few years. Yet, despite the proclaimed cost savings and efficiency improvement, implementation of the virtualization involves high degree of uncertainty, and consequently a great possibility of failures. Experience from managing the VMware based project activities at several companies are reported as the examples to illustrate how to increase the chance of successfully implementing a virtualization project" (p.01). After all of the research, you need to be able to put it all together. Hsieh (2008) covers just that, a way to put it all together and implement a successful virtualization project.

II. Risk Management Through Virtualization

Redundancy is very important in any environment as well as disaster recovery. Virtualization addresses these two risks very well. Virtual environments are highly redundant because the virtual images can be moved between different physical servers. This also makes the technology well suited as a disaster recovery solution. With physical servers, the

data must be moved to a separate device like a tape or hard drive as individual files on the server. If it becomes necessary to restore a lost server, you first have to acquire a physical server, load the operating system, update it, and then start restoring files. With virtual servers, although you can still maintain the backup of individual files for ad hoc file restore, you can make an image of the entire server in real time, including even the information that is in the server's memory. As for the risks involved in migration, they are low. If you backup your physical server, and then perform a physical to virtual conversion, you can power down the physical server, but retain it and the data in the case that something goes wrong in the P2V conversion process. Risk management is a major part of the overall enterprise strategy. Risk management is a primary reason for the implementation of the virtual environment in the first place, above and beyond the many other benefits of virtualization. Almost anything that goes wrong in IT on any scale or within any scenario can be overcome if you have a good backup of your systems. Insistence on backups that are performed regularly, tested, and stored off site, whether this is on magnetic media or a remote SAN system, is important. The assurance that this is done will be part of the role of the CIO or IT Manager and should be an expectation from others in management that this service is being provided and documentation should also be provided as verification.

Violino (2009) not only emphasizes the importance of virtualization and disaster recovery as independent concepts, but also establishes a link between them. Violino (2009) says "Hordes of organizations have embraced server virtualization as they look to consolidate servers, reduce energy consumption in the data center, increase business agility and reduce costs. But there's life for virtualization beyond the server: The future of this technology likely will focus on client devices, and there's also great potential in areas such as business continuity, disaster recovery and capacity planning." (p. 01). Violino (2009) continues to establish the linkage and shared benefit, "Another likely trend is the use of virtualization for business continuity and disaster recovery. Efforts to provide adequate backup in the event of systems disruptions have become a high priority for many organizations, and some believe that virtualization is a natural fit for business continuity and disaster recovery" (p. 01).

III. Implementation of Virtualization Using Vmware

Project Component: Stakeholders

Meeting with stakeholders is a very important step in any project. In fact, without knowing the needs of your stakeholders, it is impossible to successfully complete any project. In the case of this project, we need to meet with our stakeholders and determine several things: First, we need to verify the budget of the project. We need to know how much money is available for the project. This will let us know how may physical hosts that we can virtualize during the project and what type and quality of equipment and servers that we can purchase. Secondly, we need to verify the cutover window, which is the available time frame to make the move from the physical servers to the virtual servers using the P2V process. Lastly, we need to define the project scope. If we do not define the project well, the stakeholders may try to add tasks during the project, jeopardizing the completion. We have to try to eliminate any scope creep.

Project Component: Project Planning

Creating a project plan and timeline is important. We have to know how long the project is going to last, who is involved, and what the steps are that are involved in completion. Planning involves taking the needs of the stakeholders and the available budget, and designing a series of tasks with a timeline to do the most that we can within the available time and budget.
Steps to project completion:

1) Meet with the stakeholders
2) Create a project plan and timeline.
3) Purchase the physical hardware for the virtual environment.
4) Install ESXi on the physical hardware.
5) Use the P2V process on all physical servers. This may span several downtime windows.
6) Verify functionality with the stakeholders.

Project Component: Purchasing

Purchasing the physical hardware for the virtual environment is a key component of the project. Using the budget that we have acquired from our stakeholders and management, we must acquire the hardware that fits best with our needs and the money that we have available. This is why it is a good practice to get quotes from multiple hardware vendors, unless you have a set discount in place from a vendor like Dell or CDW. We also need to understand that the quoting process takes time, potentially several days depending on the scenario. Once we have and acceptable quote, we can purchase the hardware. Remember that once the order is placed for the hardware, it might take one or two weeks to arrive, so it is a good practice to have that time accounted for in your project plan.

Project Component: Installation

Installing ESXi on the physical hardware is a simple process, but there are several key things to remember. Once you have received the hardware, it must be unboxed, and then mounted in whatever

racking system that you have in place. For most, that will be a standard four post rack or cabinet. Then, all of the power and network cabling, along with any KVM cables must be connected and secured. Once this is done, the ESXi software can be installed. By now, we should have downloaded the install disk from the web and burned a bootable DVD. Now we can turn on the first server with the bootable DVD in the drive and go through the simple installation process. The key information to have during the install process is a hostname for each physical server, and IP address, subnet mask, default gateway, and DNS information. I would not suggest the use of DHCP where servers are concerned. Also, we will need to set and remember a password for the root user during the installation. Once the ESXi operating system is installed on the server or servers, we then need to download and install the VMWare client onto a workstation so that we can manage the virtual servers.

Project Component: P2V Process

During the planning phase, we should have met with our stakeholders and determined our available windows of downtime for the physical to virtual conversions for all of the servers. This is a critical step in the project. If you have balanced out the load and space of each host server, you should be able to perform your physical to virtual conversions in a single weekend. However, you may need to schedule a follow up weekend just in case. The process of physical to virtual conversions usually takes one or two hours per server. The first step in this process is to download the VMWare converter tool and install it on all of the servers that are to be converted. One at a time, hopefully according to a set order, you can run the software a perform the conversion. During this process, it will be necessary to connect to the virtual host, so you will need the IP address along with the username and password to perform the conversion. Once the conversion is underway, there will be a one or two our wait, during this time, you can be running the process on servers that are being virtualized to different hosts. Once the process is complete, you will need to shut down the server that you just converted and start up the new virtual server using the desktop client. Once you assign the correct IP address information to the new virtual server, it should be ready for use.

Project Component: Verification

Verify functionality with the stakeholders or at least a test group is critical to the success of the project. Not only do we need to test that all applications work, but also that we have the performance that we expected. There may be a need to tweak the memory or other resources given to each virtual server so that you get the performance that you need.

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