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Emerging Virtualization Technology

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Abstract

Virtualization represents a class of technologies that covers a wide range of applications and implementations. Virtualization can be applied to hardware or software and the technologies within the umbrella of virtualization are growing. Some organizations are adopting virtualization technologies for the cost savings benefits, but they may not weigh the risks. Bizarro and Garcia(2013) write, ?"As the technology becomes more standardized, server virtualization has become more prevalent. Companies are realizing cost savings and greener computing. Virtualization may initially appear attractive because of additional capabilities and cost savings, but those benefits come with increased security risks.?" (p. 11). As the idea of virtualization grows, so does adoption, and new improvements and virtualization technologies are emerging. Every emerging virtualization technology or innovation, however, has pros and cons or benefits and risk. Many of the emerging virtualization technologies represent an implementation challenge for project managers and implementers. This research paper will be focused on emerging virtualization technologies, implementation success factors, and virtualization risks.

Index terms—

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Author: e-mail: mrscroggins1974@gmail.com Abstract-Virtualization represents a class of technologies that covers a wide range of applications and implementations. Virtualization can be applied to hardware or software and the technologies within the umbrella of virtualization are growing. Some organizations are adopting virtualization technologies for the cost savings benefits, but they may not weigh the risks. Bizarro and Garcia(2013) write, "As the technology becomes more standardized, server virtualization has become more prevalent. Companies are realizing cost savings and greener computing. Virtualization may initially appear attractive because of additional capabilities and cost savings, but those benefits come with increased security risks." (p. 11). As the idea of virtualization grows, so does adoption, and new improvements and virtualization technologies are emerging. Every emerging virtualization technology or innovation, however, has pros and cons or benefits and risk. Many of the emerging virtualization technologies represent an implementation challenge for project managers and implementers. This research paper will be focused on emerging virtualization technologies, implementation success factors, and virtualization risks.

2 I.

3 Problem Statement

rends in virtualization are always maturing and new technologies are rapidly available for implementation. (Bele & Desai, 2012) According to Hamersly and Land (2015), a significant problem exists because some IT professionals are unable to successfully adopt new virtualization technologies. The general IT problem is that many IT professionals are not able to successfully implement new virtualization technologies. The specific IT problem is that some IT project managers lack information of the relationship between organizational culture and the successful adoption of new virtualization technologies.

4 II.

Virtualization Violino (2009) writes, "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. The server virtualization market continues to grow, although it's maturing, according to industry experts." (p. 28). So, what is virtualization? Virtualization technologies represent a very broad category of tools and technology that present many advantages to an organization. Virtualization is the concept or process of separating the logical from the physical. Rouse and Madden (2013), define server and desktop virtualization as "the concept of isolating a logical operating system instance from the client that is used to access it." (p. 1) Virtualization technologies allow an organization to literally do more with less as more technologies can be deployed onto a smaller set of physical hardware. For example, a virtualization software platform or hypervisor, can host virtual computers, servers, or devices that all exist on the same hardware and share physical resources but run different operating systems and existing within different virtual networks.

Much of the focus on virtualization technology in the industry and in the literature is on server virtualization. Despite this, server virtualization is neither the origin of virtualization nor the area where most innovation is emerging. As stated, there is a focus in the industry on hardware or platform virtualization. This refers to creating a virtual machine, and is integral to the processes of server or desktop virtualization. This is the area of the technology where most administrator work with virtualization through hypervisor applications like VMWare or Microsoft's Hyper-V. This type of virtualization is popular, not only because of cost savings, but because it allows a server or computer running one operating system to also run a second operating system through virtualization. A common

5 Mobile Virtualization

Mobile virtualization is a true representation of an emerging area of virtualization technology. Mobile virtualization technology is an embedded software technology for use in mobile phones. In Mobile virtualization, the hardware and the data and applications are separated through the use of a hypervisor. This separation allows the phone to run in an optimized way and consume less power and memory. This design is incorporated across multiple phone, notebook, and tablet platforms, including Windows CE 5.0 and 6.0, Linux 2.6.x, Symbian 9.x, eCos, pITRON NORTi and pC/OS-II. (Ameen and Hamo, 2013)The primary driver for Mobile virtualization cost reduction in the manufacture of mobile phones. Mobile virtualization is tied directly to creating lower cost phones and is part of the business strategy for Android. A good example of this is Android's decision to produce smartphones without a separate baseband processor. This is achieved by running the baseband processor code and the applications in separate virtual machines on one processor. (Hookway, 2010) Every industry has a need to reduce costs, and the mobile phone industry is no exception. Virtualization technologies reduce costs whether on the small scale like with phones or on the larger scale of servers and data centers. The cost savings of virtualization technology is what draws many stakeholders to investigate virtualization in the first place. Pogarcic, Krnjak, and Ozanic (2012) write, "The calculation proved that the application of virtualization software can lead to significant positive economic effects. In the observed example, a saving of almost 57.63% has been achieved." (p. 6). In the end, the technologies that organizations implement have to align with the financial needs of the organization, which usually means saving money. Few organizations can evaluate new technologies and exclude the financial impact, whether it is positive or negative. Our goal in IT should be to align our technology goals with the business.

6 IV.

7 Data Virtualization

Data virtualization is an emerging virtualization technology area that may be fruitful for new research, or for expanding existing research into. The research and discussion of virtualization technology is expanded into the overarching business intelligence models which includes software applications and analytical technologies that relate to the organizations data. Data virtualization, as a technology, abstracts data such that the source of individual aspects of the data whether databases, fields, etc. are presented on a common data access layer and the end client is blind to the source. This allows a single methodology for data access regardless of how or where the data is stored. (Ameen and Hamo, 2013)on the benefits of data virtualization technology, Bologa and Bologa (2011) write, "Providing a unified enterprise-wide data platform that feeds into consumer applications and meets the integration, analysis and reporting users' requirements is a wish that often involves significant time and resource consumption. As an alternative to developing a data warehouse for physical integration of enterprise data, the article presents data virtualization technology." (p. 110).

Another way to describe or think about data virtualization is that data virtualization is an approach to data management. As an approach to data management, data virtualization allows an application to retrieve and manipulate data without having any technical details about the data, including the format or physical location. This is very important for data integration or when data is presented from multiple sources. In stark contrast to the old methods of extracting, transferring, and importing data, data virtualization allows data access with no requirement for the data to move anywhere. In addition to saving costs, this reduces the risks associated with moving the data, like data corruption. Data virtualization does not impose any format on the data, so the reformatting is not needed, and can speed up implementations that access the data.

V.

8 Memory Virtualization

Memory virtualization is an important aspect of modern computing, whether applied to an individual computing device, or a clustered environment. Memory virtualization technologies include expanding usable memory by using disk space, sharing memory between clustered devices, or sharing physical memory in a hypervisor environment. As an example, a guest operating system in a hypervisor environment expects to get a zero based memory environment, because it expects real hardware. The hypervisor, for instance VMWare's ESX, provides the illusion of physical hardware by adding an additional layer of memory addressing. (Ameen and Hamo, 2013) Memory virtualization also allows for the decoupling of physical hardware so that is can be shared in clustered or pooled environments. In this scenario, RAM, or Random Access Memory, is allocated by the virtualization software and shared out to a pool. Once this is done, then the memory in the pool is available to any computer in the cluster. The memory virtualization application that many administrators are most familiar with is Microsoft Windows' virtual memory feature. As with other operating systems, the virtual memory feature in Windows is facilitated by managing memory using both hardware and software. In the case of Windows, memory addresses are mapped to virtual address rather than physical addresses. Then the system can direct these virtual addresses to either physical memory or to disk storage. This allows for optimized operation when running multiple programs, as the data in memory can be moved to disk when programs are idle. Compatible CPU hardware is also capable of mapping virtual addresses directly through the use of an embedded MMU, or Memory Management Unit. There are several benefits of using virtual memory in this way including freeing application from the requirement to use a shared memory space, more security from memory isolation, and being able to use more memory than is physically present in the computer system, a technique called paging.

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11 VI. Desktop/Application Virtualization

Desktop virtualization describes the ability to display a graphical desktop from one computer system on another computer system or smart display device. (Von Hagen, 2008) The simplest example of this is what people know as remote desktop. Desktop virtualization separates the desktop and application from the physical hardware. In this case the entire desktop can be virtualized or merely a single application, what is sometimes called application virtualization. Remote desktop in practice is a client/server configuration. Remote desktop is often used for remote support, high latency environments, or where secure or display only environments are desired. Remote desktop also allows the use of Microsoft Windows functionality on non-Windows devices like phones or tablets. Remote desktop can also be used as a cost saving measure by using inexpensive, low powered desktops that access virtual desktops on shared servers. This creates an environment that is centralized and easier to manage for administrators. The equivalent Linux application to Remote Desktop is X Windows. (Ameen and Hamo, 2013) Desktop virtualization has many applications and benefits far beyond that of Remote Desktop alone. Gareiss(2008) writes, "An emerging technology destined to resolve many IT headaches without prescription medication is desktop virtualization. The technology helps IT staffs deliver functionality to remote workers faster and with more control than using traditional means. Desktop virtualization abstracts a desktop workload (operating system and applications) from desktop hardware." (p. 1). These features are facilitated by using a thin client on the client side. A thin client can be very simple in design, or offer all of the standard features of a desktop like sound and USB connection. While dedicated thin clients are available, some organizations use old desktops or inexpensive desktops in place of dedicated thin clients.

12 VII.

13 Storage Virtualization

According to Ameen and Hamo(2013), Storage Virtualization is "the emerging technology that creates logical abstractions of physical storage systems. Storage Virtualization has tremendous potential for simplifying storage administration and reducing costs for managing diverse storage assets." (p. 65). A simple example of storage virtualization is a storage array, or disk array. A storage array uses virtualization, along with hardware and software to enable better functionality and provide additional features. This includes increased speed and reliability. Storage arrays, which are specially designed computers, implement virtualization in one of two ways, block virtualization or file virtualization. Block virtualization is the separation of logical storage from physical storage; this separation allows for greater flexibility in managing and allocation the storage. File virtualization eliminates the dependency the data access request and the physical location of the data.

Storage virtualization gives flexibility to administrators, reduces costs by sharing resources, and adds speed and security to data functions. Weil(2007) writes, "At its most basic, storage virtualization makes scores of separate hard drives look to be one big storage pool. IT staffers spend less time managing storage devices, since some chores can be centralized. Backup and mirroring are also much faster because only changed data needs to be copied; this eliminates the need for scheduled storage management downtime." (p. 20). In the recurring theme of the other virtualization technologies address, storage virtualization is primarily a cost saving measure, despite the other benefits. All of the benefits like reduced administration time and flexibility in the end result in lower cost for the organization, which helps to align IT with the financial goals of the organization. Storage virtualization requires complicated coordination of software and hardware configuration along with planning by implementers.

14 VIII.

15 Network Virtualization

Network virtualization separates the network hardware from services that are delivered over the network. This is achieved by using both hardware and software together in a single administrative combination. This combination allows the separation of a network into virtual networks, called VLANs. This separation is very common in modern network environment and done for many reasons. On reason to use virtual networks is to separate users for security reasons. Another might be to 13 Year 2017

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simplify administration by providing different services on different virtual networks. A real world example of this practice is using virtual networking to separate voice and data traffic on a local network. In this scenario, the windows server and IP phone server both have DHCP addressing enabled, such that any device plugged into the network can receive an IP address from either server. However, you only want the windows server to give addresses to windows machine, and you only want the phones to get IP addresses from the phone server. Virtual networking allows an administrator to separate one network into two, so that the windows data is on one virtual network and the phone traffic is on another virtual network.

Again, network virtualization comes down to cost savings and economics. Teeter (2011) writes, "Healthcare organizations must test their network infrastructures for disaster recovery and emergency mode operations, yet most can't afford to operate the complicated protocols needed for safe testing. The Adjustable Network architecture offers a solution." (p. 48). According to Teeter (2011), virtual networks also add high availability, security, and flexibility to networks. While flexibility is nice, availability and security are critical needs for any network. Even in environments that are not in the business of life or death data, like healthcare, availability and security are a must for the organization. Most modern organizations grind to a halt when the network goes down because most of the work is on the network. Organizational process, documents, and systems all need the network to function and transmit data.

17 IX.

18 GRID computing

Grid computing is another way to abstract or separate multiple computers or servers from the application or services that they are providing. Unlike a cluster however, in grid computing, the server do not need to be identical or even located together. Computing grids provide more capability, but require more coordination. (Ameen and Hamo, 2013) Grid computing can be thought of as a collection of computer resources from multiple locations that are working together to create a common goal. These resources may not be permanent and computing devices might only be part of the grid for a short time. A good example of this idea is the SETI at home program produced and distributed by SETI, or the Search for Extra Terrestrial Intelligence program. SETI designed and distributed software that connected user's desktops to SETI servers. This software ran on the desktop as a screen saver and processed data for SETI remotely when the computer would have otherwise been idle. The desktop software was provided for free and the installation was voluntary. At the time, Reichhardt (1999) wrote, "Three months after it began, Seti@home, an innovative scheme to enlist public help in the search for extraterrestrial intelligence (SETI), already has more than a million volunteers linking their PCs to the cause." (p.). Many other organizations have adopted this model, like the Human Genome Project. Grid computing clusters are sometime called super virtual computers.

The most important thing to understand about grid computing is that computers are brought together to achieve a common task, and which point the grid is dissolved. This grid typically using existing networks, much of which are public and often unsecured. Grid devices may enter or leave the grid suddenly, so contingencies must be programmed in to account for any unprocessed data. Computing grids are best suited for data that can be broken up and processed in different amounts, according to the ability of each device on the grid.

19 X.

20 Clustering

Clustering is "a form of virtualization that makes several locally-attached physical systems appear to the application and end users as a single processing resource. This differs significantly from other virtualization technologies, which normally do the opposite, i.e. making a single physical system appear as multiple independent operating environments." (Ameen and Hamo, 2013, p. 65) Unlike a computing grid, clusters are built to be permanent, at least for the life of the application, which may mean years or decades. The hardware in clustered environments must have physical interconnectivity and the server hardware must be nearly identical. In a clustered environment, one system does the processing or work and the other system or systems are idle, at least in terms of that function. Only when needed, like in a disaster, does another computer take over control of that process. In a cluster, the individual computers are called nodes. In the typical design, each node in the clusters will be the primary node for one function. Cluster nodes are also connected to the same storage device, usually a storage array.

A simple example of a cluster might be two servers running Microsoft Windows Cluster Services. In the scenario, there is a file share and several printers being shared. On each server, the file share and the printers would be configured identically. Each server would have access to the cluster configuration utility where the file share service and printer share service could be monitored and changed. In an active-active configuration, one server would handle the file share and have the service assigned to it by the cluster management tool. The other server would have the printer service assigned to it. This configuration makes use of the computing power of each server to do something rather than sit idle. If there is a failure, one service would fail over to the server that was still up and functioning. In an active-passive configuration, one server would run both the file share and printer share services and the other server would stay idle until needed.

XI.

21 Server Virtualization

This paper has thus far included research and commentary on many forms of virtualization technology. However, server virtualization, in common parlance is the "big enchilada." Server virtualization technologies drive the industry and provide the computing backbones for organizations. Cloud computing, remote hosting, and virtual private servers all rely on server virtualization technology. HP (2009) defines server virtualization as referring to "abstracting, or masking, a physical server resource to make it appear different logically to what it is physically. In addition, server virtualization includes the ability for an administrator to relocate and adjust the machine workload." In other words server virtualization takes the resources of one computer or server and divides them up among guest operating systems that are unaware, for lack of a better term, of the host hardware or even that they themselves are virtual. This is facilitated by a type of software called a hypervisor. There are many hypervisors available, but one that has a very large footprint is VMWare's ESX platform. Hypervisors are able to facilitate not only the running of multiple virtualized systems, but also systems that vary in their operating system. Hypervisors are even able to host systems that would not be able to run on the host hardware through a process called emulation.

There are many advantages of server virtualization including cost savings, flexibility, performance advantages, and the optimization of resources. Server vitualization is a streamlining and optimizing technology that can have a significant impact on an organization. Bridges (2013) writes, "Visualization is an enabling technology that allows multiple operating system environments to be consolidated onto a single server, which reduces the amount of hardware that is required to run the entire bank's infrastructure. Adding virtualization technologies changes the shape of the existing IT infrastructure. A bank can also choose to outsource some IT workloads to cloud providers. In that case, it is the cloud service providers that use virtualization technologies to enhance their ability to manage their hosting infrastructures." (p. 14).

22 XII.

23 Summary

As shown, there are many different types of virtualization technology, each with unique benefits and risks. One thing that these virtualization categories have in common, however, is that they are changing as new virtualization technologies emerge, and the label of virtualization is applied to more areas of IT. Some of the common themes across all of these technologies are cost savings, flexibility, scalability, and simplified administration. Virtualization encompasses many technologies and types of technologies, but the family of virtualization technologies is growing as new things emerge, and as new uses are discovered for existing virtualization technologies. [1]

Time-Sharing System, or CTSS. (Ameen and Hamo, 2013)As stated, virtualization refers to a class of technologies rather than to one specific technology. The list below shows the major classifications of virtualization technology:
1) Mobile Virtualization
2) Data Virtualization
3) Memory Virtualization
4) Desktop Virtualization
5) Storage Virtualization
6) Network Virtualization
7) Application Virtualization
8) Grid Computing
9) Clustering
10) Server Virtualization
Ameen and Hamo, 2013

Figure 1:

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