

Server Virtualization and the Push Towards a Virtual Future

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BENEFITS OF SERVER VIRTUALIZATION

Abstract

This paper explores some of the benefits that businesses will experience by integrating server virtualization into their information technology (IT) infrastructure. The benefits listed in this paper come from NH Learning Solutions (2017) article, where they provide a list of their top five benefits of utilizing server virtualization and provide their reasonings as to what makes those benefits stand out. To further support these points with more detail, this paper uses various resources. Some of these resources are used to further express the benefit a business can get out of virtualizing their servers, including a personal interview with James Ambrose (2019) with his elaboration on several of these benefits, and Kaushik Pal (2015) to provide more information about the security of server virtualization. In the end server administrators (admins) should be able to see how several (if not all) of these benefits can positively impact their business, and if they have not already, they should look at integrating server virtualization into their business.

Keywords: server virtualization, information technology, administrator

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With technology being a dependent aspect in everyone's day to day life, it is important that people are able to access the websites that they need to reliably and consistently. Many businesses have been able to accomplish this successfully by having reliable servers that they maintain on a daily basis. Traditionally, servers are hosted on physical machines that the company stores on or off site. As server traffic begins to increase, the company needs to install more servers in order to maintain the workload between the machine(s) and the network. Although this has worked for many years now, installing, configuring, and maintaining these physical machines consumes a lot of time for administrators, and costs companies quite a bit of money between purchasing hardware, software, and licensing of applications. What if companies began to look at newer ways of managing their servers that will not only improve the way their IT department is ran but help the growth of the company in the long run as well. One of the ways that businesses can do so is by integrating the use of virtual machines to create virtual servers into their business model. To better understand virtualization and how it may be the right direction for businesses to move towards, this paper will examine several resources to help elaborate on what server virtualization is and the benefits that it can provide for any business.

Literature Review

Many companies have begun the conversion process of taking their physical servers and virtualizing them, but what exactly does the term “server virtualization” mean? VMware, one of the most well-known and highly respected companies who specialize in virtualization technology, defines server virtualization as, “the process of dividing a physical server into multiple unique and isolated servers by means of software application” (VMware, 2019). Essentially what this means is that one physical machine (in this case one physical server) is

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capable of running separate and independent servers inside of itself, or rather simply a computer inside of a computer.

There are three different types of server virtualization: full virtualization, para-virtualization, and OS-level virtualization. In an article written by Lithmee (2019) she explains the difference between full and para-virtualization. Lithmee describes full virtualization as utilizing a hypervisor, which is a software that monitors the physical resources of a machine and keeps the virtual images independent of each other (Lithmee, 2019). With this method, guest operating systems communicate directly with the hardware of the physical machine to perform tasks. Para-virtualization is similar to full virtualization, in regards that it also utilizes a hypervisor. However, rather than communicating directly with the hardware of the physical machines, the guest operating systems send requests via drivers to the hypervisor, then the hypervisor sends that request to the hardware. Finally, VMware (2019) describes what OS-level virtualization is. Unlike full and para-virtualization, OS-level virtualization does not utilize a hypervisor. Instead, the host operating system takes on the responsibility of the hypervisor, and monitors the physical resources of itself as it hosts guest operating systems (VMware, 2019). A special note about OS-level virtualization, the previous methods allow for the flexibility of different operating systems to be ran, whereas in OS-level virtualization the guest operating systems must be the same as the host operating system. As each type has their unique attributes and capabilities, any of these three types of virtualization methods are capable of working with any business as it fits their needs and current architecture.

Regarding hypervisors there are two different types: native hypervisors and hosted hypervisors. In documentation written by Oracle (2018) for their *Concepts Guide for Release 3.4*, they define native (also referred to as *bare metal*) hypervisors as, “software systems that run

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directly on the host's hardware to control the hardware, and to monitor the guest operating systems" (Oracle, 2018). Examples of this include, but are not limited to, VMware ESXi, Microsoft Hyper-V, Oracle VM, and Xen. The other type of hypervisor, hosted hypervisor, is described as, "designed to run within a traditional operating system. In other words, a hosted hypervisor adds a distinct software layer on top of the host operating system, and the guest operating system become a third software level above the hardware" (Oracle, 2018). There are many applications of hosted hypervisors, such as Oracle VM VirtualBox, Microsoft Virtual PC, and VMware Server and Workstation. Both types of hypervisors are typically implemented in full virtualization set ups.

Some companies may feel as though their servers work fine the way they currently are, and that trying to incorporate virtualization technologies into their business is more of a hassle than it is worth. Admittedly, when initially taking a gander at server virtualization it can be a lot to digest. Also, perhaps servers run fine with their current configurations. However, with how far along virtualization technology has come, big names like VMWare and Oracle provide easy to install and configure virtual machine documentation online that everyone can understand and implement into their business. Server virtualization shows signs of providing major benefits that not only make the lives of server administrators easier but help the growth of the company as well.

In an article written by NH Learning Solutions (2017), they provide five great benefits to server virtualization. One of these benefits is the reduction of hardware costs. As previously mentioned, whenever a server begins experiencing an increase in its workload, businesses will order more physical machines in order to balance the workload between the machine and network activity. However, there may not be a need to do so, as NH Learning Solutions claim

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that most servers only utilize 5-15% of their resources (NH Learning Solutions, 2017). This is a tremendous waste of resources, not to mention a waste of money from a business standpoint to not get their complete bang for buck. Rather than wasting time on configuring and maintaining each physical server, administrators can begin to consolidate their physical servers into multiple virtual servers. In doing so, businesses will spend significantly less money on physical machines, while better utilizing the resources on the machines they currently own. Businesses will find that licensing costs will decrease as well due to less physical machines required to have a license. Many licenses now for programs and applications come discounted if the required product is being used in a virtual environment, further cutting down costs of licensing for businesses.

On top of reduced cost, server virtualization also improves the provisioning and deployment process. Because there is a need for less physical hardware to configure and maintain, administrators are able to utilize tools that come with virtual machine technologies to deploy servers faster. For example, if a business needs another server due to increased activity, it only takes several clicks of the mouse to copy an image of one of the virtual servers running and load up another virtual server that is an exact replica of the one copied. All of this can be done in as simple as 30 minutes. NH Learning Solutions states, “Companies with virtualization environments already look back and cringe at the grueling process of filling out a purchase order, waiting for the server to arrive then waiting hours for the operating system and applications to finish installing,” (NH Learning Solutions, 2017). Being able to quickly implement a new server not only saves time for administrators, but also keeps server traffic flowing healthily. By being able to deploy a new server quickly, businesses can quickly react to increased server activity, or be prepared for predicted increased activity on days such as black Friday where many people are all viewing the same website at roughly the same time to find the hottest deals. This also

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provides a better experience for viewers wishing to access the company's website, especially in an era where obtaining information quickly can be the deciding factor in say, a viewer becoming a customer for that company if their information loads quickly, or a customer staying with that company for enjoying the ease of access and reliability to connect to their servers.

Along with improved provisioning and deployment, another benefit to server virtualization is improved disaster recovery. Disasters are inevitable, from natural causes to human errors to cyber-attacks, unfortunately servers will never be able to prevent these events from occurring. However, virtualization technology helps secure a business's infrastructure by providing features to help with quick and simple recovery options. One of the easiest ways to recover from a disaster with server virtualization is being able to copy an existing image of a server and load it up as a new image. This not only helps keep server activity live and healthy, but it also reduces administrative tasks of reconfiguring and reimplementing security measures (NH Learning Solutions, 2017). Rather than spending the long and tedious hours dealing with a typical recovery process, it is far simpler to copy and paste an image and wait only thirty minutes for a server to come back up online. Or rather than even copying and pasting a new image, admins can utilize snapshot features that come with virtualization technologies. Much like a camera, snapshots are used to record a virtual image at a specific point in time, so that in the instance an error occurs the user can revert to the last taken of that image before the error even occurred. Of course, this means if there were any updates that came after the snapshot was taken users would have to update their images, but this is far easier to do rather than having to completely wipe the storage of an entire physical server and reinstall and configure the entire machine.

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Infrastructure is a large factor in the maintenance and progression of a company, and without a solid infrastructure one slight mishap may potentially cause a lot of damage to not only a company's reputation, but their finances as well. Server virtualization is a great way to solidify a company's infrastructure as there are many great security features that come with the design of virtualization. In an article written by Kaushik Pal (2015) he provides examples as to how virtualization strengthens the security of company servers. For example, while virtual machines can be used to run servers, they can also be used as sandbox environments which are virtual images that are used to execute untested code or programs from outside sources that are untrusted (Pal, 2015). Instead of immediately implementing code or programs to company servers, best security practices suggest using sandbox environments first for testing. In the off chance that there is a virus, or an attack is prompted via program, the sandbox is harmed rather than the immediate server(s). This saves administrators from having to roll back servers (or worst-case scenario, wipe them of all data) and spend their time reupdating and configuring servers, as opposed to working on more productive and innovative tasks for the company.

To further elaborate on this point, another strengthening aspect regarding security is the separation of virtual servers on physical machines. Although one physical machine may host multiple virtual servers, the servers act independently from each other and cannot typically be affected by neighboring images. Not only that, but virtual networks can also be created for the virtual servers, further separating the servers from the actual network of the company. This decreases the likelihood that even if an attacker were able to successfully attack a server, by having the servers hosted within virtual networks the attacker will not be able to attack anything beyond that virtual network. Even then when the attack is discovered by administrators, they can isolate that server from the network to prevent further damage and troubleshoot how the attack

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happened. By taking the time to troubleshoot the attack, admins can then implement a security measurement and then apply that all other servers that could be affected by that attack as well.

Another benefit to server virtualization described by NH Learning Solutions is increased productivity with server administrators. Admins are typically fairly busy people, between constantly checking in on the current architecture and infrastructure of their IT department, and looking at ways of improving their department, it is never a dull day for the life of a server admin. Constantly having to check on each physical server and perform routine updates on each machine is a time-consuming task. With server virtualization, an admin has fewer physical machines to maintain, and routine maintenance is far easier to do from one machine than it is multiple. As previously mentioned, provisioning and deployment become far simpler with the implementation of virtualized servers. Because of the decreased time it takes for deployment, admins can spend more time on driving new business initiatives, cutting expenses and raising revenue (NH Learning Solutions, 2017). Not only that, but tasks that have been queued in a backlog can be finally caught up with business demands or catching up with other technologies and applications that are being integrated into the industry.

Finally, NH Learning Solutions states that another benefit to server virtualization is significant energy cost savings. This ties into the benefit mentioned in the beginning of this paper, reduced hardware costs. Because of the reduction in physical machines required, a company needs less energy to power their machines. Regarding the reduction of physical machines, NH Learning Solutions states, “Cooling and power costs are significantly reduced, which means not only will you be ‘going green’, but you will also have more green to spend elsewhere” (NH Learning Solutions, 2017). Another factor with reduced hardware costs also includes reduced ventilation costs as well. Since traditional servers require a lot of space, and

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given the number of servers typically required, the room that servers are housed in can generate a lot of heat. In order to combat this, server rooms are typically designed to have special ventilation that not only keeps the room cool but also reduced humidity in the room as well. With the amount of money that is saved in this process of reducing physical hardware, that money can be used to help accelerate the growth of the company, whether that be by implementing newer technologies or expanding the growth of the company in other areas.

To further back up this point, in a personal interview with James Ambrose (2019), a site reliability engineer at Centene Corporation, he shares his experience of working with virtual machines and how they are cost efficient. Regarding the topic, Ambrose states,

“Virtualized servers are great for saving energy. They are incredibly elastic when it comes to having them when you need them, and when you don’t it’s no big deal. Servers typically experience a lot of activity during company work hours, while they experience a lot of low time off work hours and late in the evening/morning. Before virtualization, physical servers would need to stay powered on at all times, as by powering them off may affect end user experience, or even conflict with programs or applications on the server. With server virtualization, you can save energy by consolidating your physical machines to virtualized ones, and you can keep more servers active with the added benefit of saving energy” (Ambrose, 2019).

Not only do servers save on energy, but they provide an efficient way to keep more servers active at a reduced electricity bill for the company and a more reliable experience for end users. Even in the instance that many virtualized servers are not needed for the company during off hours, those servers can be scheduled to power down at a specified time. They can even be

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powered back on at specified times or powered on if servers begin to experience increased activity.

While this paper has covered five benefits to server virtualization, there is one more topic to discuss that better explains how some of the previously mentioned benefits work. The last topic of this paper is the process of automation. Regarding virtualization technology, automation is the process of writing code to create a more hands-off approach for administrators. As mentioned earlier, it is far simpler with virtualization technology to provision and deploy a virtual server than it is a physical one. Not only that, it is also far easier to maintain a virtual server because of the use of automation. With automation and the use of programming languages such as python and yaml, a company can create scripts for processes such as updating drivers/applications, monitoring server activity, or creating dash boards to easily access multiple virtual machines. In the interview with James Ambrose, he discusses how the industry is beginning to utilize automation more often by saying, “Automation is the key to efficiently run virtual servers. Ideally you should have scripts for every routine task that you need to perform. If you are clicking more than once for routine tasks, you are spending too much time” (James Ambrose, 2019). When it comes to virtual servers, most companies are looking at an approach of keeping humans out of the equation as much as possible. In doing so, server admins will spend less time working on mundane routine tasks and looking towards the future of their company rather than being stuck in the present.

Discussion

Although there are many great benefits for server virtualization, it is by no means the perfect solution for every business. As mentioned in the beginning of the paper, learning about virtualization technology can be time consuming. Not only that, but for

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administrators to figure out how to implement this new technology into their current business architecture and infrastructure is a challenge. Some of these challenges conflict with several benefits mentioned in this paper but can be explained.

Limitations of These Studies

Challenges that conflicts with the benefits mentioned specifically derive from the information presented by NH Learning Solutions' (2017) article. Limiting aspects of server virtualization include lack of statistics, reduced cost, and performance. These limitations can be explained by Ambrose (2019) and an article written by Dan Olson (2019).

Statistics limitations. There are plenty of benefits described in many articles and by virtual machines companies to help persuade businesses to begin virtualizing their servers. However, there is a lack of statistical data regarding these benefits, such as how much time do administrators save in productivity or how does reduction of hardware affect costs. While the lack of statistic does not have direct impact on the benefits mentioned, it would help admins persuade upper management or human resources to approve funding for conversion process. It would also provide more insight to admins to determine if the time is right for them to begin the process of virtualization. There are two potential explanations for the lack of statistical data on benefits of server virtualization.

One explanation being that some of the benefits mentioned are difficult to quantify numerically or even attempt to record from a business standpoint. For example, there is no efficient or accurate way to statistically record how much productivity time is increased for an admin by virtualizing their servers, or providing an accurate average to how much money a business saves by implementing server virtualization.

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The other explanation is that businesses may not want to record or release that information publicly. When addressing this concern to Ambrose, he claims, “It would be cool to see those numbers, but that does nothing for the growth of the company. It consumes too much time from multiple departments to keep track of those numbers and hold on to those files. Plus, if that information were to go into the wrong hands, it could give attackers an idea of what technologies specifically we are using and learn of ways to infiltrate those technologies” (Ambrose, 2019). Of course, this is Ambrose speaking on behalf of his company and his word should not be generalized that this is how all businesses view this matter.

Reduced cost limitations. While there might be a reduction of cost on physical hardware, there is also an entry fee that does not typically get considered when making the switch to virtualization technologies. In Olson’s (2019) article, he expresses, “Initially, virtualization may appear to save you a bit of money. But, this is a process that takes effort and should be done properly the first time. In order to account for that attention to time and detail, you may be spending more than originally anticipated” (Olson, 2019). Although there is an initial barrier of entry regarding finances, if admins properly research the technologies they need and have spent the time understanding how to fit server virtualization into their architecture and infrastructure, expenses should not be anything more than what they would over years of sticking with physical machines.

Performance limitations. NH Learning Solutions claimed that current servers are only utilizing 5-15% of their resources. By that logic, one physical machine should be able to run many virtual servers, right? Well, although the virtual servers are only images of an actual server, adding more virtual servers can begin to weigh down on the physical machines resources. Olson (2019) expresses how performance can decrease using virtual servers by saying, “A VM

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runs in layers on its hosting systems so unless you use one program or server, any operation using extreme performance will see a lowered quality of performance (Olson, 2019). Even though computers continue to increase in power each and every year, they still have their limits on tasks that can be performed. Plus, just because a physical machine is not utilizing 100% of its resources, does not mean it should be pushed to using its maximum resources. Some resources should be reserved or left available in the instance that server activity increases dramatically and needs additional resources to maintain activity.

Another factor for admins to consider when virtualizing their servers, is remembering that although more servers are being added to the company's network, the company's network can only receive so much traffic. Regarding how virtual servers and network traffic, Ambrose (2019) uses an analogy:

“Think of your servers as buckets, and your network as a hose. Sure you may have plenty of buckets, and you think that adding more will help complete your task of say filling up a pool. But even though you add more buckets, you still have to consider your hose. The hose is only so wide and can only support so much water coming through it. If you were to somehow try to force more water through that tube, you run into risk of your tube breaking. In that case, no water is able to get to your buckets and you have a major problem” (Ambrose, 2019).

Admins should factor in if there needs to be an increase in servers due to activity, it needs to be considered if the network supports the number of servers active. Having additional servers online means nothing if the network cannot support the increase of people attempting to connect to those servers.

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Conclusion and Future Study

Server virtualization offers many benefits from both a business and technological perspective. Many companies have already made the transition into a virtual technologic environment, while many other companies are either beginning to explore or have not even thought about making the transition. For businesses who have thought about it, now is a good time to consider implementing server virtualization technology as there are plenty of resources that are not only easy to research and learn, but plenty of other resources can provide even more benefits of server virtualization. To further understand how server virtualization can not only fit into a business's infrastructure, but why it is the technology business's should start implementing, determining and releasing statistics about several aspects such as reduced hardware cost, improved productivity times with administrators, and improved security should be investigated.

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