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Virtualization

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For nearly three decades, the International Legal Technology Association has led the way in sharing knowledge and experience for those faced with challenges in their firms and legal departments. ILTA members come from firms of all sizes and all areas of practice, all sharing a common need to have access to the latest information about products and support services that impact the legal profession.

Statement of Purpose: ILTA is the premier peer networking organization, providing information to members to maximize the value of technology in the support of the legal profession.

EDITOR'S NOTE

As defined by Webopedia.com, virtualization means "to create a virtual version of a device or resource, such as a server, storage device, network or even an operating system where the framework divides the resource into one or more execution environments."

Virtualization benefits to date include server consolidation (and the associated space and cooling costs), simplified disaster recovery, safe testing and training environments and adding more processing power to a server during peak times, to name just a few. Virtualization has yet to hit its stride, and we look forward to seeing many more benefits as it matures.

Our authors introduce virtualization, share how it was initiated in their firms and look at a number of consolidation options. Many thanks go to them for their expertise.

Ken Hansen, Editor

International Legal Technology Association

by David M. Rigali of Husch & Eppenberger, LLC

A Virtualization Primer

Virtualization isn't the next big thing. Virtualization is now being adopted across many industries as a means for delivering real business solutions. Firms or companies that aren't on the virtualization bandwagon yet, probably should be. If you are new to virtualization, this article will help you understand how the technology works and how it is changing the computing landscape. If you are already familiar with virtualization, the information presented here should still be useful to share with those in your organization who need to understand why investing in this technology is critical to your overall IT strategy.

So just what is virtualization? Simply put, virtualization is the representation of hardware in software. Physical components like memory, processors and hard drives can be represented in software as virtual components that look and act like the real thing. To an operating system, a virtual hard drive is no different from a physical hard drive. The advantage is that the virtual drive is generic regardless of the actual physical drive on which it is created. The operating system doesn't need to be configured for a specific type or brand of drive. In other words, virtualization hides the physical characteristics of hardware, a concept known as abstraction.

Strolling Memory Lane . . . Virtually

The concept of virtualization is nothing new. As far back as the 1960s, mainframes used virtualization to run multiple instances of the operating system at the same time. This allowed expensive and scarce resources to be partitioned, which in turn allowed for timesharing applications that could run independently of each other. The personal computer made it more affordable to distribute processing power, and by the 1980s, virtualization had faded to the background. The concept could still be found in features like the Windows HAL, or "Hardware Abstraction Layer," introduced in the early 90s as a way to hide the complexity of different hardware components from the operating system. Only recently, however, have advances in software and hardware made full virtualization possible on industry-standard servers.

Virtualization as we know it today takes the concept to its logical conclusion. Instead of various components being represented virtually in software, an entire computer can be represented, complete with virtual hard drives, virtual memory, virtual processors and virtual network interfaces. So complete is this virtual computer that you can actually run a shrink-wrapped version of Windows (or other operating systems) on it and standard versions of applications on top of that. To the operating system and applications, the virtual computer looks and acts like the real thing.

Virtualization Provides Concrete Benefits

This might be little more than a cheap parlor trick if it didn't turn out to have some very important applications. Chief among these today is disaster recovery. One of the challenges of building a disaster recovery solution is replicating all of your hardware at a remote location. If the hardware isn't close to a perfect match, you could, during an actual disaster, spend a lot of time reinstalling software on the new hardware. Virtualization offers a solution. If your applications are installed on virtual servers, they can be quickly recovered on virtual platforms at the disaster recovery site without having to consider the type or brand of the actual hardware. Better still, the virtual server, complete with its installed operating system and applications, can be contained in just three or four files. This feature is known as encapsulation. The files can be easily restored on a virtual platform at the remote site and the server quickly brought up, fully configured and tuned as it was before. Recovery times can be dramatically reduced. Keep in mind that this isn't just theory; many organizations are doing this now.

Slaying Server Sprawl

The benefits don't end here. Virtualization can substantially reduce the number of physical servers in your environment by taking advantage of the excess capacity in your data center. Most servers today are substantially underutilized. This is due to a number of factors. Advances in hardware continue to outpace software, while at the same time (to the delight of CFOs) the hardware continues to get less expensive. There is also a tendency to install servers as single applications. For example, we wouldn't dream of running an accounting application on the same server running our e-mail system. As a result, more and more servers are deployed across the organization resulting in "server sprawl." And let's be honest. We also tend to "over-engineer" solutions, throwing as much hardware as possible at the problem with the hope of sailing through periods of peak demand. The result of all this is that most servers are running at a fraction of their capacity. Virtualization can take advantage of this.

It's clear that virtualization is here to stay and will play an increasingly important role in IT.

Virtualization allows multiple servers to be installed onto a single hardware platform (not unlike the multiple operating systems on mainframes during the 1960s). The virtual servers operate independently of each other, meaning that if one virtual server crashes, it won't take all of the other virtual servers on the same machine with it. Thus, virtualization can play an important role in data center consolidation. Virtual platforms running at 60 percent utilization and higher, while delivering acceptable performance for each of the individual virtual servers, are common. Imagine a six-fold or greater consolidation of physical servers in your environment. The reduction in space, power and cooling requirements alone represent a significant reduction in cost. Once again, your CFO will be smiling.

And There's More . . .

Virtualization can also provide many benefits for daily operations. For example, at peak processing times, such as the end of the month, you can temporarily add more processing power to your accounting servers. You can then reduce this when peak demand has passed. In fact, in the right environment, you can even move virtual servers from one physical platform to another, while they are running. IS can perform maintenance and upgrades on platforms without taking virtual servers down. These and other operational efficiencies can improve service and maximize your firm's investment in technology.

Too Good To Be True?

At this point you're probably asking yourself, what's the catch? For starters, virtualization software itself isn't cheap. In addition, to fully realize the advantages of virtualization, you'll want to run the software on state-of-the-art hardware, for which you'll pay a premium. Virtualization also benefits from shared storage solutions like SANS, which can be expensive. Still, in a carefully planned environment, overall server acquisition costs can be lowered. Another challenge is that some software vendors have been reluctant to certify their applications on virtual environments, mostly because it adds another dimension to their support requirements. This is changing, however, and organizations like ILTA can provide advocacy for encouraging vendors in our industry to support virtual platforms.

Beyond the Virtual Server

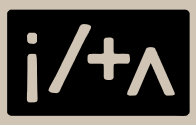
Virtualization isn't limited to servers. Desktops can be virtualized as well. VMware refers to this as simply another use case. Your future desktop could be virtual, accessible anywhere from any device. Your laptop could be a simple, lightweight device with no moving parts, connecting to your virtual desktop back at the office. IS would be able to centrally manage your desktop regardless of where you are, applying updates and upgrading applications as needed. Sensitive information would never actually leave your data center. If your laptop were lost or stolen, there'd be nothing important or confidential on it. All of the data would still be on your virtual computer back at the office. The security implications are enormous. If this sounds like the thin client solution we've been talking about for years, it is. Industries like health care are taking advantage of this new paradigm even now.

It's clear that virtualization is here to stay and will play an increasingly important role in IT. Last year, more than 7,000 people attended the VMworld Conference in Los Angeles (See www.vmware.com/vmworld/ for information on the 2007 conference in San Francisco. If you want to come up to speed on all things virtual, it's a worthwhile event to attend.) Vendors are also starting to deliver applications as virtual appliances, providing fully configured virtual servers that can be dropped into your virtual environment, ready to go. Even if you aren't ready to adopt virtualization in your production environment, consider applying it in your test and development labs as it offers the ability to quickly set up and tear down servers as needed. In fact, this is a common strategy for introducing virtualization into your IT environment.

Resting the Case for Virtualization

In summary, two of the key concepts to remember about virtualization include abstraction, or the hiding of physical characteristics of hardware from the software running on that hardware; and encapsulation, which refers to containing entire virtual machines in a single or small number of files. The chief benefits of virtualization include disaster recovery, server consolidation, operational efficiencies, virtual appliances and even new paradigms for delivering computing services to end users. All are areas important to meeting the IT challenges most firms face today.

Other articles in this issue will give you more technical detail and provide case studies outlining how virtualization is being used in legal environments today. It is our goal that this information will help you and your organization understand where virtualization can fit into your IT strategy and how your firm can benefit.



by Dean Leung of Davis LLP

Cost-Effective Virtualization

From Desktop to Data Center

The use of virtualization technology will save you time, money and resources in IT operations and business continuity planning. Virtualization can be utilized in workstation application testing, server prototyping, mission-critical applications and as the foundation component for a robust and cost-effective business continuity plan. With three tiers of product offerings from the two key players in virtualization technology, it is possible to realize the benefits of virtualization with minimal initial investments. Capital investments are preserved as the adoption of virtualization moves from the desktop, to the data center and finally to the disaster recovery (DR) site.

At Davis LLP (formerly Davis & Company LLP), the use of virtualization was not the goal of a rolling three-year technology plan, but once the various options for infrastructure improvements were investigated, virtualization emerged as the most logical technological choice. What started as a cost-effective means of testing desktop applications and patches prior to deployment in year one evolved to the full virtualization and clustering of core servers in the plan's final year. With both native and third-party tools, we are now able to replicate the virtual machines to the backup data center without the need for expensive SAN/LUN-based replication software.

Virtualization Defined

In the context of this article, virtualization is the abstraction of an operating system (*e.g.*, Windows, Linux and Netware) from the physical hardware. This allows for several operating systems to run independently from one another on the same physical hardware. Each virtual machine (VM) is allocated RAM, CPU, NIC, storage, etc., independent of other virtual machines which may have different operating systems (OS) and configurations. The operating system running inside the virtual machine (also known as the guest OS) sees a consistent set of hardware regardless of the configuration of the physical hardware. The virtual machine itself exists as several files which can easily be copied or backed up to another location. These VMs all run on physical hardware which is running an appropriate host operating system (typically Linux or Windows Server) and virtualization software. This virtualization software is an intermediate layer between the physical hardware and guest OS and controls the number of processors, total CPU speed, RAM and storage to which each VM has access.

Firm Background

Davis LLP has eight offices with seven in Canada and one in Tokyo. The main office in Vancouver has more than 300 users, three offices have between 50 and 100, and four more offices each have between six to 20 users. With IT support primarily based out of the main office in Vancouver, the firm moved to a centralized data center model and timed this move with the replacement of servers due for retirement. This reduced the need for IT expertise in each office and lowered overall operating costs as the need for space, power and cooling in each office dropped.

In early 2006, to support the centralized data center and to ensure equal application performance regardless of geographical location, the firm upgraded the interoffice WAN links to a MPLS meshed network of varying speeds dependent on office size. The upgrade also included a backup hub-and-spoke VPN connection to Vancouver in the event of an MPLS outage. The remote and overseas offices now connect into the private WAN via VPN connections with the fastest available Internet connections. More information on this configuration along with details of the VoIP implementation and business case can be found in an article titled "Keeping It Current – A Case Study in Building Voice and Data Communications Infrastructure" in ILTA's February 2007 white paper on voice and data communications.

With the WAN in place, this new foundation provided the infrastructure required to consolidate our servers and replicate data to the DR site for business continuity. We timed this centralization to coincide with the migration away from GroupWise e-mail and DMS. In order to ensure sufficient performance and to add an extra layer of redundancy in the event the already fault-tolerant WAN failed, we implemented DMS caching servers in each remote office and set the Outlook client on the desktops to caching mode.

At the core, each of the SQL 2005, Exchange 2003 and Interwoven DMS servers were configured with clustering. This allows for a failure or system maintenance with little or no effect to the user. It also allows IT to perform maintenance on a node of the cluster without the need to shut down the entire system. This is especially important given that these servers now host the data of the entire firm rather than an individual office. With eight offices across four time zones, there are only four hours when all Davis LLP offices are closed.

With this level of required redundancy, and ignoring ancillary needs, the following servers were needed:

Data Center

- 2 SQL 2005 servers with MS clustering (2 processors each)
- 2 Interwoven DMS servers with Interwoven clustering (1 processor each)
- 2 file servers with MS clustering (1 processor each)
- 1 index server (2 processor)
- 2 Exchange 2003 servers with MS clustering (2 processors each)

Each Office

- 1 file server (1 processor)
- 1 DMS cache server (1 processor)

With seven offices in addition to the main data center, this required a total of 27 servers: nine servers in the core, 14 servers in other offices and four servers required at the backup data center. Through the use of virtualization, we were able to implement the new system with a total of 10 physical servers. Of those, only two are new purchases while the balance are existing underutilized 2U servers that have been repurposed.

During the process of designing the centralized infrastructure a number of questions in three key areas arose.

Performance

- How do we better utilize new and existing hardware?
- How do we improve performance for certain server applications as required?
- How do we simplify hardware upgrades?
- How do we minimize the downtime associated with hardware maintenance?

Physical

- Where do we find the additional space for the new servers?
- Do we have sufficient power and cooling required to run these servers?
- How do we manage the growing number of workstations hosting critical applications?

Business Continuity

- How do we ensure cost-effective business continuity now that we were putting all our eggs in one basket with a consolidated data center?
- How do we recover from hardware failures in offices with no IT staff?
- How do we accomplish DR with heterogeneous servers and storage platforms without requiring identical equipment at the primary and backup sites?
- How can we achieve SAN-level replication without the associated costs?

All questions were resolved via the use of virtualization. The answers to these questions served as the basis for the business case to utilize virtualization technology over traditional bare metal servers.

Performance Savings

Industry analysts report that only 10 to 15 percent of a typical server CPU is utilized at any given time. This is not entirely surprising since it is common to host only a single application per server. Isolating each application ensures that the failure of one does not take down any others and accommodates the need for high CPU cycles on a periodic basis such as month end. That server may then sit idle for the balance of the month. Beyond the CPU, many components of a server are underutilized. This includes gigabit network cards, excessive RAM and hard-drive space. This is even more prevalent with “workstation servers,” those desktop PCs that make their way into the server room to host required applications that are not sufficiently mission-critical to justify the cost of a proper server.

For tangible items such as office space, one would never consider it appropriate to utilize only 10 to 15 percent of the space. Through the use of virtualization, it is possible to improve the utilization of existing server resources while preserving the need to isolate one application or OS from another. This also allows for optimum performance from a greater number of applications with more running on server-class hardware. With the use of tuning tools supplied with data center-grade virtualization products, profiles can be set up to dynamically allocate additional resources during peak periods such as month end.

Through programming sleight-of-hand, virtualization software can report two processors to the VM as one processor with a CPU speed that is the aggregate speed of the two physical processors. This allows nonSMP aware (*i.e.*, single processor) applications more resources than was previously possible.

With virtualization, upgrading hardware or recovering from the failure of an underlying physical machine becomes trivial. This simply involves purchasing the new hardware, installing the appropriate virtualization software, copying the VM files to the new server and starting the VM.

Physical Savings

Servers are relatively inexpensive to purchase, but the rising costs of powering, cooling and housing servers are often overlooked. The use of virtualization technology allows for the consolidation of servers to limit server sprawl which will, in turn, lower operation costs. Overall, this reduces the total number of servers which need to be purchased, provisioned and maintained.

Business Continuity Savings

Traditionally, disaster recovery sites had to have hardware identical to the primary site, which amounted to a very expensive "insurance policy" for hardware that might never be used. The complexity of data centers also required staff with specialized technical expertise at the DR site to manage the technology.

Since virtualized servers are hardware independent, the old paradigm no longer applies. It is now possible to have lower-cost hardware, even from different vendors, at the DR site with the only requirements being that the hardware is supported by the virtualization software, and that there is sufficient CPU, RAM, bandwidth and storage to run the required virtual machines.

As virtualization evolved in our firm, the technology was expanded beyond the desktop to include the lab environment.

When properly configured, server-class virtual machines are identical to that of desktop VMs. Because of this simplicity, only minimal expertise is required to enable the VMs once they are replicated to the DR site.

Determining Which Products To Use

At Davis LLP, we use three different lines of products from VMware including VMware Workstation for desktop development, VMware (GSX) Server for the lab and VMware (ESX) Infrastructure for the primary and backup data centers. Our initial choice of VMware was due in part to the lack of competition at the time we began using the product for desktop development. However, we also considered the ease with which we could migrate to their enterprise class software. For those who are just jumping into virtualization, competing products from Microsoft and the open source community offer other options.

Desktop — VMware Workstation

With sufficient RAM, VMware Workstation runs on a user's desktop and allows for an independent guest OS to run without interfering with the operations of the host operating system. Although completely independent of the host, you can copy and paste as well as drag and drop files between a Windows-based host and guest operating systems. The operating system can be a desktop or server OS which can be utilized for prototyping a new operating system (*i.e.*, Vista), testing new applications and patches and for training/classroom environments.

Three features which are particularly useful in our environment are the clone, snapshot and revert features inherent in all versions of VMware. With the clone feature, you can take a virtual machine and replicate it to another independent instance, which can run on the same desktop or copied for use elsewhere. We use this to copy our base desktop environment, which takes only a few minutes compared to the time it takes to build one from scratch.

The snapshot feature allows you to set a point-in-time snapshot of the operating environment and, at some future time, revert back to the snapshot thereby rolling back any changes (or damage) done to the environment. This is useful in application and patch testing as well as in the classroom. Once training is completed, the VMs can be reverted back to their original snapshot to reset the classroom for a new class. This can also be useful in situations where multiple training environments are required, such as migrating to a new DMS platform. Note that once the VM is developed on the full version of VMware Workstation, there are no costs to install multiple copies of the VM player in order to run the VM on training machines. However, appropriate licensing of the guest OS is required.

Lab Environment — VMware Server/ESX Starter

As virtualization evolved in our firm, the technology was expanded beyond the desktop to include the lab environment. This was driven by the dual need to move applications that were prototyped on the desktop and still have them available when the desktop host OS was unavailable. Also, if multiple VMs were required to run simultaneously, this caused a burden on the desktop environment which was still required by the user for day-to-day operations.

In this environment, we installed VMware on server-class hardware. While initially we used the free version of VMware Server (formerly VMware GSX), which runs on either Linux or Windows 2003, we eventually moved to VMware ESX Starter on the lab servers. The ESX version of VMware comes with a host OS which is a variant of Linux and is not significantly more than the cost of a Windows 2003 Server license. Since we were prototyping server operating systems, we felt it more prudent to parallel the full production environment which uses ESX.

Once deployed, we were able to easily copy VMs from the desktop environment to the server. Using VMware Converter (formerly P2V Assistant), we were also able to clone our existing servers into VMs on the lab server. VMware allows you to create virtual subnets which completely isolate the virtualized servers from the production network. This makes it possible to test server patches and server interoperability with configuration changes prior to applying them to production machines. You are, however, limited to virtualizing servers that do not require specialized hardware peripherals (such as RightFax and VoIP servers that do not have corresponding VMware drivers).

Using virtualization, we were able to replicate more production servers in the lab with costs far below what would have been required to replicate the same functionality using physical servers.

All new servers begin life in the lab, which allows for testing, tuning and benchmarking for resource requirements before they are moved to the production VMware ESX servers. Another benefit is being able to quickly deploy a new server by cloning a base-server image. This can be done without the need to purchase additional hardware or to delete

another test server that is not virtualized. If resources become limited, virtual machines that are not in use can be shut down and moved to secondary storage until needed.

Production Data Center — VMware ESX/VIN

When the time came for our team to pitch the use of virtualization for core servers in the data center, the justification was already in place as desktop development, lab and secondary servers were already virtualized and in production.

While the use of virtualization technology for the desktop and lab environments has very low barriers to entry, there are costs associated with enterprise products that host your mission-critical systems. However, we were able to justify the use of virtualization in the data center solely by comparing the hard costs associated with purchasing the 16 nonvirtualized servers with the cost of two new and eight repurposed servers as well as the appropriate VMware licenses. Savings from space, power and cooling were a bonus but not included in the business case.

Server Hardware — Blades Versus Big Box

At the time of our analysis in early 2006, we were faced with choosing between high-density blade servers and traditional high-end, multi-processor servers. While a similar analysis today may yield a different result due to the evolution of blade technology, we opted for the traditional servers.

One of the fundamental concepts of virtualization is the ability to pool physical resources such as CPU, RAM and storage and allocate those resources as required to the appropriate virtual machines. This concept lends itself better to the use of a small number (at least two for redundancy) of high-capacity servers as opposed to the large number of lower capacity servers used in blade technology.

Blade servers have a high density and share common network, power and external storage but are unable to share CPU or RAM between blades. At the time we did our analysis, the cost of the RAM required to run multiple virtual machines on the blades was prohibitive. In addition the amount of RAM was limited, which meant a larger number of blades and, by extension, CPUs would be required to handle the requisite VMs. This resulted in more costs associated with VMware licenses, which are licensed per CPU. In the end, we determined that blade servers would be the optimal choice if we were not using virtualization as many of the benefits discussed in the physical savings section also applies to blade servers.

For the primary data center servers, we chose to use a pair of quad-processor, dual-core servers with Intel Xeon 3GHz processors with eight total processors and 16 cores between two servers. Each server has 26GB of RAM and small 72GB, mirrored hard drives sufficient to boot VMware ESX and connect to the SAN.

Each server currently runs 15 virtual machines which include the nine mission-critical servers required for e-mail and DMS. Also included are cost recovery, Citrix, AD, file/print, intranet and monitoring services. We ensure each node of a cluster is on a different physical server to provide hardware redundancy, and we distribute the load between the two servers to maximize CPU utilization by assigning the active node in each cluster to alternating servers. By design, the CPU utilization of each server runs between 25 to 50 percent during peak business hours. This provides a sufficient buffer to allow for one server to host all critical VMs if necessary for hardware maintenance or in the event the other physical machine fails.

Storage Hardware

Both servers are connected to a SAN which hosts all the virtual machines. This is a requirement for fault tolerance using VMotion which is discussed in the next section. We chose an IBM-branded NetApp SAN due to price, market acceptance and presence of both Fibre Channel and iSCSI ports. Due to the cost and complexity of a Fibre Channel network, we wanted to limit adoption of this technology to the two core servers which required the additional disk I/O performance provided by Fibre Channel.

For secondary servers not yet virtualized due to the life cycle of the underlying hardware, we connected these servers to the SAN using a dedicated gigabit switch and specialized iSCSI ethernet network cards in the computers. This allows consolidation of data on the SAN for storage, backup and replication with minimal additional investment.

VMotion

The key rationale for using a SAN is to take advantage of the VMotion functionality available in the VMware Virtual Infrastructure Node (VIN) product, which includes VMware ESX. Simply, VMotion can monitor the health and utilization of resources of the physical server and dynamically move a virtual machine to another physical server in the event of a hardware overload or failure. In order to accomplish this, the virtual machine files need to be on common storage available to all physical servers which could host the VM.

This functionality can also be used to relocate VMs in order to upgrade or maintain a physical server. While this relocation can be accomplished without shutting down the virtual machine, there is a loss of one or two pings to the VM as the system is transferred. Resilient applications will have no issues with this blip, but with others an error can occur.

Disaster Recovery

The use of dual servers connected to a SAN and VMotion provides the necessary fault tolerance in the data center, but virtualization is also the basis of the firm's business continuity plan.

As discussed in the business continuity savings section, virtualization offers full hardware independence which frees us from the need and cost to replicate the production data center hardware at the backup site. The only criteria are that sufficient CPU, RAM and storage be available and that the destination hardware is supported by VMware.

At the backup site, we implemented a single quad-processor, dual-core server. To minimize costs, we opted for direct-attached storage (DAS) since, with only one physical machine, VMotion is not a requirement at the DR site. We chose this configuration for several reasons. First, we needed to manage costs. Second, this was the DR site, which is meant to be used only in the event of a catastrophic incident, such as failure of the fault-tolerant systems at the primary site. Third, since half of the users are located at the primary site, if there was an incident, there would be a significantly lighter load on the servers.

Backup and Replication

While virtualization technology has matured, there is not yet a cost-effective and all-encompassing backup technology to address the needs of the backup and replication of VMs. For this, we use several best-of-breed products, which include traditional backup agents inside the guest OS, esxRanger for VM backup and esxReplicator for VM replication.

To leverage our investment, we continue to use existing disk-to-tape and disk-to-disk backup agents to back up data inside a guest OS as we originally did on nonvirtualized servers. However, this can become costly as more VMs are added, and it does not allow for the backup of the entire VM and configuration files on the host servers.

VM backup can be done simply by shutting down the guest OS and copying the VM files to a new location. However, this would create periodic downtime of each OS for the duration it takes to shut down, copy and restart the virtual machine. The use of esxRanger alleviates this issue. esxRanger runs on a separate Windows 2003 Server, which could also be a VM, and performs a backup and compression of the VM and configuration files. It does this by taking a snapshot of the VM and creating a full or differential backup of the snapshot. The resulting zip files, which are typically compressed between 20-40 percent, can then be preserved via traditional backup methods. It is also possible to use the supplied viewer to extract a particular file from the backup without first restoring the VM.

To further simplify the backup and replication of mission-critical data, we use esxReplicator which can be run from the same machine as esxRanger. esxReplicator performs scheduled asynchronous replication of VMs to another VMware ESX server. It does this by first doing a full compressed replication to the destination ESX server followed by the replication of changed data, also compressed prior to transfer. Across a WAN this can be bandwidth-throttled and creates a point-in-time snapshot at the backup site. If the primary and backup data centers are configured for the same VLAN all that would be required in the event of a failure of the primary site is to boot the replicated VMs.

While esxRanger and esxReplicator have an impressive feature set and represent a dramatic cost-savings over traditional SAN/LUN-based replication products, there are a couple of disadvantages. One is that the replication is asynchronous. This may or may not be an issue for your organization and depends on your disaster recovery targets. Also, neither product is capable of backing up the shared disk space in a Microsoft cluster. This can be addressed, however, using traditional backup and restore methods for transaction logs.

Lessons Learned

For those who are starting off with virtualization, here are a few pointers:

Install the multi-processor OS from the start. Having the SMP HAL installed when initially building the OS, even if you only intend to have one CPU, will allow you to quickly allocate and utilize another virtual CPU as needed.

Buy support directly from the vendor, not a third party. Regardless of the relationship, buying support directly from the vendor has provided us with faster and more knowledgeable response.

Not all servers should be virtualized. Run any prospective virtual machines in a lab to ensure they are good candidates to virtualize. Applications which are resource and specifically CPU hogs should not be virtualized.

Start slow. The low financial barriers to entry for the desktop and lab-class virtualization products allow you to start realizing the benefits of virtualization and expand the use of the technology as budget allows.

Final Thoughts

The savings in capital and operational expenses through the use of technology and the low-entry barriers should make virtualization a staple in all IT departments. While there are still some gaps in the technology required to back up and replicate VMs, these gaps are closing quickly. The technology is ready for production on the desktop as well as in the classroom, lab, server and data center environments. With Intel, AMD, Microsoft, Novell and several Linux players building virtualization optimizations directly into their respective hardware and software, it is clear that virtualization is fully mainstream and will only continue to grow and evolve.

ILTA's Core Values

:: Maximize the value of technology in support of the legal profession

:: Provide quality, independent, unbiased and accurate information to our members about technology and the practice of law

:: Maintain vendor independence

:: Provide quality educational opportunities for our members and ongoing learning for navigating through change

:: Foster, rely on and celebrate volunteers for their real-world experience and their value as a resource for colleagues

:: Recruit and retain the highest caliber of professional staff

:: Act as a vehicle for meaningful peer networking

:: Respect our colleagues

:: Commit to the highest standard of professionalism

:: Maintain a financially sound organization that provides full value for the members' investments

:: Promote member advocacy with vendors regarding product development and support

:: Recognize that ILTA is a volunteer-governed organization managed by a professional staff

by Matthew Berg of Wolf, Greenfield & Sacks, P.C.

Practically Virtual

A Pragmatic Approach to Managing Your Server Infrastructure

In my last ILTA article on virtualization, "Stop Playing with Virtualization Technology and Start Using It!" (*Supporting the Technology that Supports the Practice of Law*, October, 2005), I introduced readers to the basic concepts of virtualization. My premise for the article was that this relatively new technology deserved a closer look. Virtualization had matured and stabilized enough that it was beginning to see use in production environments. Nearly two years later, the adoption of virtualization has been even more pronounced. This article addresses some of the more practical aspects of implementing server virtualization.

The adoption of virtualization has been rapid principally because the technology enables and enhances: server consolidation, system maintenance, test environments, test deployments, simplified disaster recovery and on-demand computing.

At a more elemental level, the principle benefits of virtualization can be understood to be the standardization and centralization of managing your business servers. Systems management is easier and more straightforward when every server has the same set of virtual hardware. You don't have to develop specifications for and invest in new hardware every time your firm adopts a new application. Performance problems can often be solved simply by adding a second (virtual) processor or additional (virtual) memory to a lagging machine. Your four primary performance metrics — CPU, memory, disk I/O and network activity — are logged and presented in very easy-to-use graphs that point out where performance bottlenecks exist for each of your applications. Better still, some of the latest features offered by virtualization software include the high-availability (HA) offering (essentially "clusterless" server clusters) and distributed resource schedulers (DRS — virtual server hosts that automatically balance the workload of your virtual servers across multiple host servers.) With DRS you can achieve maximum utilization from your hardware while extracting maximum performance from your applications.

In 2005, our firm had one production, virtual-server host computer running four virtual servers (an IIS server, a certificate server, a media server and our firm's antivirus server) that performed a relatively conservative set of functions. We were becoming familiar with VMware's ESX server, and our use was limited to monitoring the utilization of each server and gauging the performance of four applications being serviced by one piece of hardware. We were also learning the art of pulling off successful P2V (physical-to-virtual) conversions.

We now have 31 virtual servers hosted on four computers. We selected VMware's ESX server as our platform of choice, so this paper is focused exclusively on VMware's implementation of server virtualization. I believe it is safe to assume, however, that the concepts discussed here will apply, at least generally, with competing products as well.

Bringing Servers Online

We build many of our virtual servers from scratch on a clean OS, though we usually cheat somewhat by using a virtual machine template that we've previously created or by cloning a fully-patched, base model machine. We put careful thought into sizing the virtual hard disks that we create for each server. We load balance the virtual servers' CPU, memory, disk I/O and network bandwidth across the three production hosts. (Our fourth host is in a colocated facility for disaster recovery.) Thanks to Virtual Center we are able to move, clone and copy our servers with a few clicks of a mouse from a central management console. We then back up and replicate copies of our production virtual servers (using Doubletake for VMware Infrastructure) to our disaster recovery site, where they sit idly awaiting the day that we might need them.

The past 18 months or so has been a steady process of learning how to "drive" our ESX servers. We do some tasks through the MUI (management user interface), others through Virtual Center. For smaller firms, especially those unfamiliar with Unix/Linux, I recommend investing in Virtual Center. It's worth every penny!

Sometimes you need the assistance of third-party applications to make things easier or at least more secure. WinSCP (for SFTP) and Putty (for SSH) work well as replacements for their less secure counterparts FTP and Telnet. FastSCP, a product from Veeam (which also comes with its own distribution of Putty), is a very effective tool for facilitating file transfers between the Windows and ESX world. But you should know that there are definitely times when you have to do the "command line thing" and dabble in the hybrid world of Linux and VMware. The vmkfstools and vmware-cmd commands are invaluable but hardly intuitive, even for someone with a Unix/Linux background. In 2.x there's vmkpcidivy, and included in VI3 are the whole series of esxcfg- commands. While this may seem daunting, you can do almost everything you need to do through the Virtual Infrastructure client GUI, especially in VI3.

At their core, these ESX servers are much more like the Linux machines that the kernel is based upon and almost nothing at all like the Windows

servers that they typically host, which are the mainstay of most law firms. That said, if you have the obvious stuff covered (most of which is outlined in this article), it should be relatively painless to learn and even fun. For those with no background in any flavor of Unix or Linux operating systems, it is definitely an opportunity to expand your skill set.

Practical Advice

Answering the following questions will help you get started and achieve the best results with virtualization.

Do you need to buy new servers? If so, what kind of server(s) should you buy? Any commercial-grade server produced by a major hardware manufacturer within the last three years (*e.g.*, HP, Dell or IBM) will work with the ESX Server virtual host kernel. But if you plan to load the server with a high number of virtual machines, choose something that can hold a lot of memory. We have standardized on HP DL385s and DL585s, and they both work very well with ESX. A dual-processor, dual-core DL385 with 8-16GB of RAM makes a great starter machine.

What happens when your ESX server goes down? Are you more vulnerable to systems failures? Essentially, the same unpredictable things that will make a Windows server go down can make an ESX server go down, such as failure of a drive which is not part of a functioning RAID, bad memory or a fried motherboard. There's no greater vulnerability to a hardware failure with ESX than there is with a Windows server. However, the consequences of a virtual host server crashing are much greater, as this single-point-of-failure affects multiple systems. It's inherent to the entire virtualization architecture. By the same token, this architecture — many separate applications operating on one piece of physical equipment — is one of the major selling points of server virtualization.

This may be an intimidating thought when you are trying to build an infrastructure that mitigates risk as much as possible. But these risks apply only in a basic VMware environment where the servers are running ESX 2.x or VI3 Starter or Standard or on a standalone ESX server that can't provide backup or failover to a partner. If you're running VI3 Enterprise or have the HA and DRS options up and running on a pool of ESX servers, all of these risks are offset by failover and automatic load-balancing functionality. These features are designed to keep all of your servers up and running at their optimal level right through a hardware failure.

How do you get a production VMware environment up and running if you're operating on a small or limited budget? If you can't risk putting too many eggs in one basket, you can start with a simple configuration. But simple should mean having at least two virtual host servers in production before you go live. Having only one server is rolling the dice with the VMs that are running on that box if you ever encounter a problem. And even if you have good backups of the virtual machines themselves, you can't move forward without a ready place to host those virtual servers. You will need to build a new ESX server and copy those virtual systems onto this server.

What about backups? You can continue with the same backup software and strategy you already have in place for your physical machines. The only difference in the virtual world is that you will be performing your restore to a virtual machine.

That said, it is wise to spend the money on a backup solution that works elegantly with virtual servers (*i.e.*, an application that is "aware" of the fact that the servers are virtual, such as ESX Ranger or NSI's Double-Take for VMware Infrastructure), especially if you'll be using virtualization to solve your DR challenges.

We originally purchased ESX Ranger for this purpose and were quite happy with the results. But in the process of fleshing out our disaster recovery solution for our SQL 2005 and Exchange data, we discovered NSI's Doubletake for VMware Infrastructure. We were convinced that if it worked as advertised, it would be an even better solution for us. So far, this has proven to be true.

How easy is using virtualization for DR, and what's the best way to go with it? With products like ESX Ranger and NSI's DoubleTake for VMware Infrastructure, virtualization for DR is very easy. Even without VMotion in play, if you have current copies of your virtual servers stored somewhere safe and off your network, you will be able to get those servers up and running very quickly in the event of a disaster. If you want a DR solution that's closer to high availability, VI3's HA option lets you effectively "cluster" your virtual machines so that you have automatic failover in the event of a critical system failure.

What about storage? To take advantage of Vmotion (and HA and DRS), you need to store your virtual machines on a SAN. What are the concerns? If you can afford a Fibre Channel SAN, you should have no worries about performance. But if you're using iSCSI, keep in mind that the software-based initiator will steal some of your system resources. Our iManage Indexer experienced some delayed write failures to an iSCSI data volume whenever the ESX server it was hosted on experienced particularly heavy loads. As with a nonvirtual environment, there are a few things you can do to ensure that this doesn't happen to you. First, you should ensure that your network health is sound. A dedicated subnet or VLAN for your gigabit iSCSI traffic is almost essential. Make sure that your switches are configured to use flow control and "jumbo frames" and that you've got plenty of bandwidth and switching capacity available to spread around. Next, configure your hardware infrastructure and servers for multipath I/O. Doing so will provide you with hardware redundancy to ensure that your data path is always available to your applications. Finally, invest in some iSCSI HBAs rather than relying upon the iSCSI initiator software to manage your servers' I/O.

By taking these steps, we've moved our performance from acceptable to good. Our ISCSI SAN solution consists of three Equallogic Peerstorage Arrays. We have two in a production group that automatically load balance on our LAN and a third "target" array at our disaster recovery site to which the two production boxes are replicating their data on an ongoing basis.

Are there any machines or applications that are not good candidates for virtualization? I believe you should create at least one AD controller on a physical server. It was our experience that whenever we had scheduled maintenance and brought down one of our ESX servers, this invariably involved rebooting the virtual servers that came up before the AD was present, because the AD is a virtual machine. Could we have configured our virtual machines not to boot up automatically after an ESX server restart? Yes. But for us, the convenience of the servers all bringing themselves back online automatically was worth creating a physical AD controller.

We took that step after this issue came up twice during major system and network maintenance activities that required shutting down our systems for a short period of time. The first time, we were implementing the stop-gap measure of injecting a new gigabit switch into our server room to offload our iSCSI traffic from the aging core switch. While nonblocking, the switch was port tight and operating under a pretty heavy load. After the brief outage, we tried to bring our ESX servers up on the new switch but experienced port "flapping" on the ESX network cards, which wouldn't lock at the gigabit speeds we needed. During the time it took us to get the ESX server up and running by manually editing a file buried in the Linux file structure of the ESX kernel, we could have had our AD up and running with a physical machine. Again, when we put the new core switch in place and turned our ESX servers back on, we experienced flapping, despite having configured both the switch and the ESX kernel to use 1 gigabit. Configuring both to auto-negotiate also did not help in this case. The problem was temporarily "solved" by moving our ESX servers back to an older Summit 7i and off the brand new Black Diamond 8800.

There are quite a few threads on many forums out there about ESX servers not playing nicely with various pieces of network equipment. And these are definitely things for you to think about and test before counting on everything "just coming back up" after a scheduled outage or network upgrade.

If you use DHCP with reservations for your servers, you might want to consider configuring that on a physical machine. For that matter, if you're using Virtual Center, it wouldn't hurt to have that on a standalone physical machine as well. We have ours running on a virtual machine right now, but it can be frustrating to attempt certain types of offline Virtual Center-driven maintenance on an ESX server that is hosting your Virtual Center server. Without another Virtual Center server, this is obviously impossible to do.

What about remote management? Select servers with the equivalent of HP's iLO (Integrated Lights-Out) for your ESX installations. If you purchase new HP hardware, you will have it built in. Invariably you're going to have to run some archaic vmkfstools command at one point or another. And sometimes you'll need the console to do so because something has gone wrong with your normal means of remotely administering the server. Murphy dictates this will always happen after you have left the office.

More Practical Advice

What have we taken away from these exercises in practical virtualization? Was it worth the effort to get this brave new infrastructure in place to support an ever-more-virtual IT environment? In our case, it has proven to be an even bigger win than we had imagined in all the areas that virtualization software purports to address. While we were establishing our virtual environment and learning through trial and error about the ESX 2.x world, VMware had been fine-tuning their products and putting some real thought into the practical features that have now come out in VI3. What once seemed the holy grail of virtualization — Vmotion — is now almost old hat when you compare it with new developments in their conversion tool and the HA and DRS options.

If you haven't committed to virtualizing your server infrastructure, begin investigating all the options available. The time to be practically virtual is now.

Realizing Increased Cost Control

And Disaster Prevention with Virtualization

by Gabriel McAtee of Project Leadership Associates

As data-center space and energy costs rise, more and more companies are looking at blade servers, server consolidation and virtualization to help control and manage costs. Additionally, disaster preparedness and disaster-recovery planning are key issues in many companies, and the associated technologies can help to address the information systems portion of those overall cost-saving efforts. Let's examine these concepts, discuss some specific solutions and look at how some of these technologies can affect the information systems environment.

Server consolidation refers to an attempt to reduce the number of physical servers in an environment primarily through one of several methods: by colocating multiple applications on a given server, by colocating multiple copies of the same application on a given server, or by virtualizing multiple servers and colocating them on a single physical server or a cluster of physical servers.

A special method of consolidation is keeping the same number of servers but using smaller servers *(i.e.*, implementing a blade server solution). Blade servers are vendor-specific and generally composed of a chassis containing somewhere between 8 and 16 individual servers called blades. Each chassis has its own power supplies, input/output modules, keyboard/mouse/video, remote access and other tools. Also, most blade servers support one or two hard drives per blade.

Virtualization refers to the use of some virtualization package to provide one or more physical servers with the ability to host virtual computers, each of which is wholly independent of other virtual computers on the same or other physical servers. There are currently several virtualization vendors in the market, but the two biggest players are VMware and Microsoft.

Virtual Benefits

The business drivers behind the push to consolidate and/or virtualize fall into three main areas: direct costs (hardware purchases and software licensing), operational costs (power, cooling and provisioning) and disaster recovery/prevention/high availability. Consolidating or virtualizing reduces the total number of physical servers in a given environment, which in turn reduces operational costs and, in some cases, licensing costs. Additionally, given the appropriate infrastructure, virtualization can provide a higher degree of disaster recovery/prevention and high availability. Provisioning refers to the cost associated with the

process of building and implementing a new server in a consolidated environment. As applications are consolidated on to a reduced number of servers, the need to build new servers is reduced. Also, in a virtualized environment, new virtual servers can be built from preconfigured template virtual machines, which takes very little time and effort.

Virtual Flavors

On the virtualization front, VMware has two main product lines which are typically used in the data center: VMware Server (formerly VMware GSX Server) and VMware ESX Server. VMware Server is a free product which is most commonly used in a laboratory or staging environment. Support is not included with the product but can be purchased separately. This is a powerful, fast and free solution that is an excellent starting point for many companies interested in virtualization. It is limited to the number of virtual machines that can be placed on a single host; no automated facilities exist to migrate virtual machines between VMware servers, nor are any clustered solutions provided.

For all of these solutions, certain infrastructure needs to be present to gain the most benefit from the servers and software.

Virtual Infrastructure 3 ("VI3") is a powerful enterprise solution that includes a virtualization engine (ESX Server) and a number of add-on services that are bundled together in three combinations. VI3 allows virtual machines (guests) to be moved manually or automatically between ESX Servers (hosts) to provide for automatic resource balancing and to provide failover capacity in the case of the failure of a host. This allows for higher use of resources available on the company's physical hardware. At the same time, it also provides a higher degree of physical redundancy than is available with a single-server solution. An important additional point for many companies is that VMware products have a much higher degree of support for non-Microsoft operating systems than Microsoft's Virtual Server.

Microsoft's latest virtualization product is Virtual Server 2005 R2. This is similar to VMware's VMware Server product. Both are free and have many comparable features. Virtual Server 2005 R2 has a higher degree of flexibility in allocating CPU resources to a given virtual machine, which can make it a more powerful tool for some applications than VMware Server. Microsoft has recently released a beta of System Center Virtual Machine Manager, a centralized tool for the provisioning and management of Microsoft Virtual Server virtual machines. While the Virtual Server product line does not have any high-availability or resource-balancing tools, it does support clustering of virtual machines both within a host or across multiple hosts using Microsoft clustering technology and an iSCSI SAN on the back end.

For all of these solutions, certain infrastructure needs to be present to gain the most benefit from the servers and software. We will take as a given that power, air conditioning and rack space are available. Key to the successful implementation of any of these products on an enterprise level is the presence of gigabit network switching and centralized storage, generally a SAN. All of these products support local disks for basic services, but to get the more advanced tools such as high availability through VMware's HA service or a Microsoft cluster, or distributed resource management, a clustered file system in the form of a SAN is required.

Virtual Economics

The economics of virtualization and consolidation are most effectively demonstrated through case study and return-on-investment (ROI) scenarios. For comparison, assume that a sizeable law firm (about 1,500 employees) has about 80 servers in its centralized data center. In this scenario, the company is growing in size about 10 percent a year, and the number of servers is growing at a rate of three to five servers a year. The firm's policy is to replace servers every four years. Therefore in 2007, the firm plans to replace 20 servers and add three to five. For this analysis, assume a total of 24 servers. Since the firm participates in Microsoft Volume Licensing, Microsoft licensing will not be directly considered in this calculation. Also, to make all comparisons equal, we will assume the firm has a single virtualization product, VMware VI3, an in-place SAN and computers purchased from a single vendor. All pricing numbers will be based on list pricing with no discounting.

The three cases the firm wants to look at are: direct one-for-one replacement to 1U SAN-attached servers; consolidation to blade servers, assuming that some applications will be able to be consolidated to a single physical server for an overall reduction in number of servers of about 33 percent to 16; and virtualization of as many servers as possible. For this case, we will assume that 21 of the 24 servers being implemented this year can be virtualized. Further, we are going to estimate that we will be able to virtualize 10 physical servers to one ESX server for a normal production load, and that in a failover scenario (*i.e.*, one of the ESX Servers failing) we could run 12 to15 virtual machines on a single host for a limited time.

1-to-1 Server Replacement

24 servers with two dual-core 3.0GHz processors, redundant power, two local 73GB disks and dual-port HBA. Approximate price for each is $9,000.00, subtotalling $216,000.00.

Average cost associated with building the 24 servers, patching them, adding them to AD, and migrating applications and data to them (assume 12 hours at $100/hr total cost) Approximate cost for each is $1,200.00, subtotalling $28,800.00.

Total Direct Costs: **$244,800.00**

Note: These servers will take up 24U of space in the data center, will require 48 power connections and 72 network connections if remote access cards are to be used.

Blade Servers with Consolidation

2 blade chassis (no blades) with dual Cisco switch modules. Approximate price for each is $6,000.00, subtotalling $12,000.00.

16 server blades, 2 dual core 3.0GHz processors, dual local disks, 4GB of RAM and HBA. Approximate price for each is $7,000.00, subtotalling $112,000.00

Average cost associated with building the servers, patching them, adding them to AD, and migrating applications and data to them

(assume 12 hours at $100/hr total cost. Approximate cost for each is $1,200.00, subtotalling $19,200.00.

Total Direct Costs: **$143,200.00**

Notes: These servers will take up 44U of space in the data center, will require 3 power connections and 4-12 network connections depending on configuration and if the remote access cards are to be used.

Virtualization
3 servers with two dual-core 3.0GHz processors, redundant power, two local 73GB disks, dual-port HBA and 4GB RAM. Approximate price for each is $9,000.00, subtotalling $27,000.00.

1 server with two dual-core 3.0GHz processors, redundant power, 6x300GB drives, dual-port HBA and 4GB RAM. Approximate price is $12,500.00.

3 servers with two quad-core 2.66GHz processors, redundant power, two local 73GB disks, dual-port HBA and 16GB RAM. Approximate price for each is $12,500.00, subtotalling $37,500.00.

3 VMware VI3 enterprise. Approximate price for each is $5,750.00, subtotalling $17,250.00.

3 VMware Vi3 enterprise support (SNS). Approximate price for each is $1,435.00, subtotalling $4,305.00.

1 VMware Virtual Center 2.0. Approximate price is $5,000.00.

1 VMware Virtual Center 2.0 support (SNS). Approximate price is $1,250.00.

Average cost associated with building the servers, patching them, adding them to AD, and migrating applications and data to them (assume 12 hours at $100/hr total cost). Approximate cost for each is $1,200.00, subtotalling $3,600.00.

Average cost associated with building a four-server VI3 production environment, 40 hours @$100/hr. Approximate cost is $4,000.00.

Total Direct Costs: **$112,405.00**

Note: These servers will take up 8U of space in the data center, will require 16 power connections and 27 network connections if the remote access cards are to be used.

Projecting the numbers above across three years we see the following:

1-to-1 Replacement
Year one costs: $244,800.00
Year two costs (assume 26 servers at similar ratios): $255,000.00
Year three costs (assume 29 servers at similar ratios): . . .$295,800.00

Blade Servers with Consolidation
Year one costs: $143,200.00
Year two costs (assume 26 servers at similar ratios): $159,600.00
Year three costs (assume 29 servers at similar ratios): . . .$184,200.00

Virtualization
Year one costs: $112,405.00
Year two costs (assume 26 servers at similar ratios): $102,260.00
Year three costs (assume 29 servers at similar ratios): . . .$105,415.00

Obviously, great savings are possible through either consolidation or virtualization.

The cost benefits of the reduced power, cooling and rack space required for a consolidated or virtualized solution are not as easy to quantify and can be significant. In many modern data centers, space and cooling are even more of an issue than direct-purchase cost savings.

A Winning Practical Application

Many companies are very serious about implementing some kind of formal disaster preparedness or disaster recovery plan. VI3 opens some very interesting and powerful opportunities to DP/DR planners. Whether considering a localized disaster (*i.e.*, fire or flood in a data center) or something more widespread such as the effects of a hurricane or earthquake, most companies' DP/DR plans include some form of offsite recovery, whether automated or manual. In either case, virtualizing the DP/DR environment allows for the significant reduction of costs associated with building the DP/DR site. For companies that have to rent space from a hosting provider for a DR site, this becomes even more attractive, as many ISPs/colocation facilities charge by the number of units taken up in the rack.

In cases where space is at a premium, a combination of blade servers, a small workgroup-level SAN and VI3 is unbeatable in terms of providing a highly redundant, compact and rapidly expandable infrastructure. While the site is strictly being used for DR, guests can be loaded quite heavily onto the hosts (20 to 1 or so). In the case of a major disaster, when that virtualized environment must be used for production purposes, it is extremely simple to add additional VMware ESX Servers to the VI3 environment and to allow the distributed resource services to load balance the guests across the new hosts.

Given the enormous benefits of virtualization, the next questions to be asked are, "What servers can I virtualize?" and "How can I easily migrate my physical servers to a virtual environment?" And those are topics for another article.

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