Learning

Virtualization and Thin Clients

Virtualization Basics

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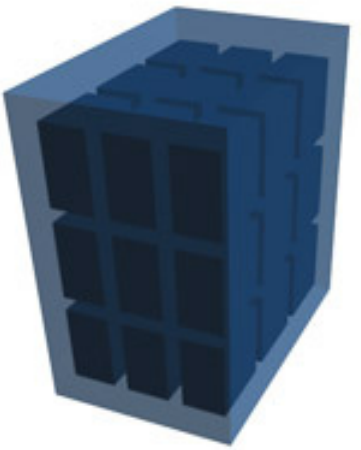
TYPES OF VIRTUALIZATION

Application Virtualization
Deliver applications to users from a central, controlled environment instead of managing each desktop.

Desktop Virtualization
Same as application virtualization except a user receives an complete desktop environment.

Server Virtualization
Create multiple software-based servers on single physical server boxes.

Storage Virtualization
Use multiple physical storage devices to create customized network storage.



We can't assume that everyone knows and understands what virtualization is—we should perhaps assume the opposite.

Even though virtualization seems to be a ubiquitous technology, understanding what it does and how to manage it is still out of reach of many IT and Engineering managers.

Virtualization is essentially taking traditional hardware like servers and reducing the number of physical machines by converting most of them to virtual machines located within fewer of these physical devices. For example you could take 30 physical servers and reduce them to 5 physical servers that each have 6 virtual servers running inside them.

Server Virtualization

Virtualization is gaining traction so quickly because for years IT departments have known that most physical machines were being seriously under utilized. Only a fraction of CPU power, hard drive storage and memory were being used on most computers, including servers.

Perhaps the greatest benefit of virtualization is that it allows IT professionals to be as efficient as possible by making optimum use of physical hardware. By creating these virtual machines IT can seriously reduce the burden and time of maintaining the physical infrastructure. In addition to IT departments becoming more efficient at managing physical devices, businesses get the added benefit of shrinking power and cooling costs.

Storage Virtualization

These same principles apply to virtual storage as well. Virtualization tools can take many different storage devices and create what appears to be one central storage configuration. Larger companies tend to use this more often since SANs (Storage Area Networks) require an even greater capital investment that just server, client or application virtualization projects.

Hard disk arrays and the additional hardware and software required to create and maintain virtual storage environments usually make this the final part of a virtualization project. Virtualized storage is not necessary to create an environment

COSTS AND SAVINGS

Costs
Hardware refresh every three to five years.

Costs
Software—virtualization software isn't cheap and the free tools don't have the support most people need to make a virtual environment a reality.

Savings
Reduced maintenance time and increased security from centralized management improves the bottom line.

Savings
Using thin clients for end-user workstations will reduce hardware refresh costs by reducing the frequency at which most hardware has to be refreshed.

that can deliver virtual desktops and applications. You may find that it makes some aspects of virtual asset management easier if projects get larger over time.

Client Desktop and Application Virtualization creates IT centralization

The two most prevalent forms of client virtualization are desktop and application virtualization. These two forms of virtualization allow for the tools that a worker uses to be configured, maintained, stored and delivered from a centralized source. Just like server virtualization reduces the amount of physical hardware to maintain, desktop and application virtualization create a more efficient way of delivering a working environment to the end user.

Instead of installing new software or weekly security patches on each physical device, IT can update operating systems, applications and security settings apart from the devices that need them. Once updated components are ready they are simply delivered the next time a user logs into their virtual environment.

Switching end users to thin client hardware and away from traditional PCs can also create long term savings. Typically thin clients cost less to purchase, maintain and have longer life cycles than PCs. Thin client hardware also reduces security issues and further drives down power usage.

All these efficiency gains speak for themselves with time saved in IT, on the plant floor or and in office environments. Downtime and overtime can both be reduced significantly by delivering user resources from a central source and the security gains are a no brainer. Why plan late night software rollouts, maintenance and security tasks when these functions can be accomplished during normal operating hours?

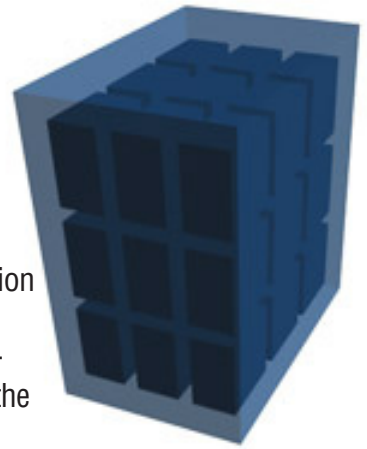
Virtual Management Issues

It would be remiss to say that virtualization doesn't have some of its own issues and inefficiencies. Even though an incredible amount of time and resources can be saved by going to virtualization, the ability to view and understand how everything is configured becomes the new challenge.

Before virtualization you could see cables and computers and have a clear understanding of what was where and who was using it. Since virtualization takes away the easy-to-see physical components, IT managers will have to find new ways of keeping assets properly organized.

Despite these hurdles, virtualization appears to be here for the long term. The positive effects seem to far outweigh the pitfalls and the cost savings are hard to argue against.

Beginning a Server Virtualization Project



In Part 1 of this series we discussed the four types of virtualization—application, desktop, server and storage virtualization. In this article we plan to focus specifically on server virtualization. While this article will look at virtualization in a general sense, we will link VMware's terminology for virtual environments, since they are perhaps the most well-known of the virtualization platforms available, to some of the generic terms for those components.

Server virtualization is perhaps the best place to start when beginning a virtualization project. There are many reasons for this but one of the most important would be that it is a bit easier, and less costly than the other forms of virtualization. It is easier because IT can maintain complete control over the aspects of the changeover without disrupting end users. Server Virtualization is less costly because you are consolidating hardware. Less hardware not only reduces physical overhead but also reduces the time that will be spent maintaining and upgrading the physical devices. It typically will mean that you simply repurpose the servers you have to handle the load or work of multiple servers.

Components Needed for Server Virtualization

Host Server(s)

This physical device is the holding tank for your virtual machines. This machine will have the CPU, RAM, and possibly HDD storage that will be shared between all of the Virtual PC's.

While it should go without saying, your ESXi servers need to be outfitted with proper CPUs, memory and hard drive space to accommodate these multiple OSs. Under-powered and under-resourced ESXi servers will not meet your virtualization goals of saving time and money. The hardware not only needs to be adequate, but also needs to be supported by VMware ESXi.

Hypervisor / ESX/ESXi

The software that runs on this box to host or provide the interface between the hardware and Virtual PC's at the virtualization layer, is called a Hypervisor in generic terms, or ESXi (newer ESX) software in a VMware environment. The ESXi as a

hypervisor is a very small and light weight OS based on Linux. It's interface is very basic, and simply provides enough ability on its frontend in order to provide some IP addressing and security.

Management Client / vSphere Client

Once this Host box has its Hypervisor installed, it will need to be managed from another machine. In a VMware environment, this host could be managed as a standalone host using vSphere Client. This tool will allow you to connect to the host, create virtual machines, and power on/off/suspend those machines, as well as other management activities. These will be "virtual" instances of the same physical servers you used to have sitting in the control room or IT department on separate pieces of hardware. Now they can all be located (installed) on a single device. The management tool will also allow you to run a window that will allow you to view and interact with these virtual machines, and share local or other data. This also allows you to install a new OS to the virtual machine. New machines can also be cloned from other machines or other machine templates. There are many tools available to completely manage this environment.

Management Server / vSphere Server

VMware also has a product that can manage multiple ESXi servers at one time, as well as virtualized or pooled network storage. This type of system can then provide a connecting client with a system connection, rather than a simple client/server connection. If any ESXi host is unavailable, the client is served by any of the other available ESXi hosts. This product is called VMware vCenter Server. While this product could be installed on a virtual machine, thereby managing itself more or less, in a typical and more robust system it will be installed on its own separate box.

This software also bridges the system with many other more advanced features. One such feature is vCenter Update Manager to provide automatic updates for the system and virtual machines. Another is VMware vMotion which provides for a seamless uninterrupted migration of a virtual machine from one host to another.

After the migration

Once the servers are migrated to a virtualized environment, you use VMware vClient or other client access tools to view and manage the OS on running on the virtualized servers. For other clients that are accessing the services being performed by the server, they will still continue to access it via the network just like before.

Benefits of Server Virtualization

Reduced Maintenance Costs

We mentioned it earlier but it's worth saying again—fewer hardware devices to maintain means fewer hardware components to manage, fewer hard drive replacements, reduced energy usage, and smaller footprint overall. According to VMware and IDC, IT staff can see a 30-33% reduction in workload by converting to a virtual environment. This time savings can be used to reduce overtime or allow IT to spend more time on optimizing other business technologies.

Less Downtime

Server failure can almost be eliminated in a virtual environment. This does not mean that redundant systems are no longer needed but by having multiple server instances available in your virtual environment you can test upgrades and other software changes in a virtual space without having to disrupt the live environment. VMware's vMotion, High Availability, and Data Recovery can be used to eliminate or greatly minimize the impact of any individual server or hard drive failure.

Server virtualization essentially creates a free testing zone for changes to server configurations since no additional hardware is required. Simply make a copy (snapshot) of a current version of your virtual server and run and many test and configuration changes as you wish. If there is a failure, simply remove the bad image and try again with the good one.

Terminal Server Virtualization

Perhaps the most optimal form of server virtualization is Terminal Server virtualization. Microsoft Terminal Services allows for one-time installation of applications that can be deployed to multiple users. Instead of installing user apps at each desktop, administrators install applications once at the server level and they can be deployed to as many users as one has licenses. Creating a virtualized Terminal Server can take server efficiency to an even higher level than virtualization alone. It reduces the amount of installation and configuration necessary when setting up applications for end users on the virtual environment.

This line of thought naturally leads to considering the desktops to which virtual applications and/or virtual OSs will be delivered. One might question the need for a fully-equipped PC for end users if all of the OS and application resources are being handled at the server level. Bingo! Using a PC as the delivery point for applications

served through standard terminal services or virtual terminal services is overkill. The only processing required at the terminal with this configuration is the video and keyboard input.

Zero Client Terminals Make Sense

So what is the best option for the end user in this environment if not a PC? Thin client computers are certainly the obvious choice considering the lower hardware cost. A thin client maintains a lower price point than its PC counterpart because it has a smaller processor, less memory, no CD/DVD drives and no hard drive or storage media at all. Many thin clients will carry a full OS on board to connect to terminal servers, but zero client or ultra-thin client computers that have no OS are becoming more common.

The benefit of zero clients is that they fully rely on their servers for the OS and other configuration information. This keeps all of the control located at the server level—essentially making the client a zero-trouble device. All application, configuration and maintenance takes place in the IT environment and the client is only used for end user access to the system, greatly reducing time and money spent on maintaining devices on the plant floor.

What You Need for Server Virtualization

Host server(s)

This physical device is the holding tank for your virtual machines. This is where the virtual machines access the CPU and RAM for their operation. This machine is responsible for the processing power for the virtual machines so you'll need to make sure it fortified with plenty of memory, hard drive space, processing power, etc., and that it is supported by your Hypervisor (the virtualization layer software).

VM Management Computer

This machine(s) will run the software that allows management of the system of host servers. In our examples we used VMware's VCenter Server and VSphere Client to configure and manage the virtual machines on our VMware host server referred to as an ESXi server.

Storage Challenges and Terminal Services Benefits

Many of the companies that adopt Virtualization architecture take the simple and seemingly straight forward approach that is VDI, or Virtual Desktop Infrastructure. This means that they simply create a Virtual Machine (VM) with a desktop Operating System (OS), such as Windows 7, and then present that VM to a client machine such as a thin client. This approach often appears to be the best move when converting users of standard PC and OS over to a virtual environment. What the user sees on the screen, and the actions they perform on the virtual machine, are nearly identical to what they have on the PC.

But, there is at least one hidden cost to this approach. As highlighted in a recent CIO Magazine article, the storage cost for this approach can be a significant increase over the cost of PC storage, and may not be known right away.

According to the CIO Magazine article, the average cost per GB of storage in the PC world is roughly 10 cents. These drives are widely available, and easily replaceable. Storage in the VM world is more difficult to find due to the needs for network connectivity, and support by the storage hosting device that is used. Also, the actual features provided by these storage systems vary and have a significant range on the cost. They could be basic SATA type Enterprise storage, or Fibre Channel Storage (http://en.wikipedia.org/wiki/Fibre_Channel). These network storage sharing devices often have a storage cost of 30 to 100 times that of a PC or IDE storage, so $3 to $10 per GB. While in a VM it is not always expected to have the same 100+GB of storage you see in a PC, it can still be a significant factor when calculating ROI and other costs for the move to virtualization.

As the VM's are built for this VDI setup, each one starts with a minimum of roughly 5GB just for the OS and some basic applications. Add to that other more significant applications and your VM image could quickly stand at 10GB, without any user data yet placed on the VM. Multiply that by the number of VM's that are needed, say 25, and you are at 250GB, or $2500 for a Fibre Channel storage solution with 25 users, and no user data is yet added. Provide just 10GB of storage for those users and you easily double the storage cost.

Here at ACP, we once again look at Terminal Services and see it as the great technology that it is. Since we already have thin clients or other RDP capable devices at the user side, let's look at how a move from VDI to Virtual Terminal Servers would help with this storage situation. First, there's only one VM that needs to be created. You could create a second as an instant backup, and given the cost savings that are expected, let's assume two VM's are created, both as Windows Server OS with Ter-

minal Services enabled and configured. Now, we install all the applications. At this point, we've instantly saved over 200GB of storage space, just by moving from 25 OS and application installs, to two. That's a savings of $2000, and the OS cost could be lower as well, depending on the licensing agreement with Microsoft.

The user experience at this point, and on a per user/terminal basis, can be configured to look just like the desktop they are used to, or simplified and locked down to provide only the application access that is needed or desired. No matter the local user type, the solution of using Terminal Services and ACP ThinManager is the answer.

Once the system is running with Terminal Services and ACP ThinManager you have access to all of the other great benefits that ACP has provided for more than 10 years. With our two server system from this example, you have just two virtual machines that require time for OS and application patching. With ThinManager you get MultiSession, MultiMonitor, TermSecure, IP Camera integration, Failover and Instant Failover, and a wide range of Thin Client options.

Server Consolidation for Industrial Automation

Anyone considering virtualizing their Industrial Automation system needs to first look at the Servers and follow a similar process that one would use for standard commercial systems. There are some special considerations for the Industrial user however, as well as some special benefits along the way. The following are some simple steps that are needed, and some elements of guidance for the Industrial Automation user. Use these in conjunction with other tools and processes that are available from many sources. One good source is searchservervirtualization.com. Using these suggestions you should be able to make your Server Virtualization and Consolidation project flow smoothly.

DATA COLLECTION

The first step is to collect data and this will likely take the most time. You need to take a complete inventory of what you have now for both hardware and software. The hardware detail needs to include the specifics for the CPU, RAM, HDD size and controller, and the make and model for the NIC(s). Software details should include specifics regarding versions, node name requirements, license file information, database needs, and any direct ties to hardware.
In the typical Industrial Automation system, you will likely come across older non-Ethernet PLC's, flowmeter's, or other data and control devices that may require some special communication cards. In some cases this may mean that it is not possible to virtualize some elements of the system. These details require noting during the data collection phase.

Another element of software data collection is the current system's performance levels. Make note of the current CPU and RAM specifications and utilization. You may want to run some Performance Monitor logs over the course of a few weeks, or even months, in order to gather enough data to reliably understand the system's needs.

The collected data should help to define the roles of the servers. You will want to put this data into some table-like form in order to easily catalogue and sort all of the collected information. While the processes and data collection styles used by commercial users might be helpful, the number of devices under review is typically much smaller for an Industrial Automation system. Given the smaller system size, a simple spreadsheet with rows and columns will likely suffice for the collection media. For the performance data, you may want to plot and print out some trends that reflect the performance utilization for the period of data collection.

SYSTEM EVALUATION

Evaluation of the available hardware and software requirements is the next step. This means taking a close look at the hardware to determine which of the existing servers will be able to act as Hypervisor or Host systems. These systems need to

have certain performance capabilities and need to have the right individual components supported by your Hypervisor. The CPU, HDD controller, and NIC are usually the most crucial components for support. Your Hypervisor vendor should not only be able to provide you a list of supported hardware, but also some level of performance expectations for the particular CPU and RAM configurations.

If your servers are newer they are likely underutilized. You may be able to simply add RAM and/or storage and have a device that can host multiple Virtual Machines. During this evaluation phase, you can determine which of your hardware boxes are usable, and what improvements they might require to get them to the proper performance level for your system needs.

The other evaluation piece is to determine software needs. The responsible Industrial Automation software vendors out there are onboard with the virtualization trend and provide information regarding the type, speed, and number of CPU cores that allow them to work best. However, you should take some of the performance information gathered in the data collection phase and determine the real needs of the software, plus some room for growth. Often even the best Industrial Automation software provider will overstate the needs just to allow for the most demanding users. The standard system is likely not taxing to the level of the vendor provided specifications.

One other element of software evaluation would be things like compatibility, dependencies, and shared space. Does the software vendor say that it is compatible with a virtual environment? Are the dependent software pieces such as a database, third-party driver, and third-party software capable and supported in a virtual environment? By reading the provided literature from the vendor, or discussing your plans with their sales or support personnel, you can answer these questions.

Is it possible to put multiple pieces of software in the same Virtual Machine? Trying to put more software into one machine is one way to increase a physical server's utilization. This will also help your virtual server consolidation just as much. It might also help to reduce overall complexity in the system. In other words, as you review the entire system, do not simply try to replace individual physical machines with virtual machines. Give the system a good overall review and use the data collected to evaluate everything in order to provide a clean and well performing system.

FINAL VIRTUAL SYSTEM DESIGN

After getting all the information from the data collection phase, you should now be able to evaluate your current resources and system software needs. You can now begin to build out the design of the system where you assign roles to the physical hardware, construct the setup of the individual virtual machines, and apportion the various virtual machines to specific physical machines. The amount of work and knowledge gained prior to this step

will greatly affect the amount of effort it takes to complete. In other words, if you have gathered all the data and evaluated it properly, this step will be a very short one and could result in a one or two page document.

Your result will be a system drawing, a list of VMs to be created, the software that will be installed on the VMs, some node name and address information, a list of things that will not be virtualized, and a list of leftover or backup hardware.

IMPLEMENTATION

Implementation involves the configuration of the hardware, the actual creation of the VMs, and bringing everything online. As with any normal Industrial System change process, you will build this outside of your existing production environment, test it, then plan your actual cutover to the new system. The actual steps here will be unique to your type of Industrial environment and its production requirements.

One thing to keep in mind is that once you have a virtualized system, recreating your system in a test bed type setup will be much easier. Because the needs for the test bed are less than production, you can use a smaller number of Hypervisor devices in order to keep a running copy of the system somewhere else.

Imagine now that you need to make some change to the system. Rather than have the old multi-machine system, or a non-complete system for testing changes, you can easily have a complete replica of what is on the plant floor. This can be handy for any plant engineer, system integrator, or vendor when working on a support issue. Rather than shipping around X number of physical machines, you simply ship portable hard drives with VMs on them and some basic network configuration information—it is just one more benefit to the Virtualization process.

STORAGE, CLIENTS AND VDIs

Other than basic information on looking at what your HDD capacity and controllers are, storage needs are not discussed here. There are several ways to implement storage in your virtual system with a wide range of capabilities, cost, and complexity. If your system is small, I would recommend keeping it simple, and just using local storage on the Hypervisor. If your system is larger, has a greater need for backup and recovery features, and you can afford it, you can look at some of the Fibre Channel (FC) and other network consolidated storage options.

While not discussed in this article from ACP, home of ThinManager, our recommendation is to make one or more of your virtualized servers a Terminal Server, then use those to feed your client stations. Whether you use Terminal Services or just Virtual Workstations, ACP's ThinManager platform will go a long way to making management of your system much easier and more feature rich than any other software solution available.

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