

Server Virtualization

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Executive Summary

This paper has been commissioned by the CUNA Technology Council in response to a growing interest in virtualization, and in particular server virtualization, by credit unions. Virtualization utilizes a software program to subdivide a physical box server into “slices.” These slices, in turn, draw upon the pooled resources of the server’s hardware for varying needs such as energy, memory, processing speed, etc.

While different types of server virtualization exist, the predominant one in the market is the virtual machine model. In this model, each slice or virtual machine is capable of running a separate operating system. With an average of 12 or more virtual machines per host server, this allows many physical box servers to be consolidated. Additional advantages include reductions in server sprawl, energy, and cooling costs and improvements in human and machine productivity.

A major benefit of the virtual environment is the ability to create, switch over, and take down virtual machines in a matter of hours and minutes in comparison to traditional box servers. Downtime for software testing is reduced or eliminated and backup and disaster recovery is markedly improved.

This paper explores different types of virtualization, with an emphasis on server virtualization and the virtual machine model. Storage area networks and desktop virtualization are also discussed. Content is at an introductory level to acquaint readers with the reasoning, basics, and challenges of virtualization. It is intended to be a helpful background tool not only for IT professionals but also financial decision makers such as CEOs, CFOs, and board members.

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Introduction

A revolution has been slowly building in a select group of credit union data centers across the nation. Virtualization, the ability to partition a physical computer server into multiple functioning machines, has gained recognition and acceptance in recent years and is now considered viable in terms of start-up costs for many credit unions.

According to CUNA's *2008-2009 Technology and Spending Report*, only 7% of credit unions surveyed utilize virtual server technology at present. Those with asset levels of \$500 million or more were 50% more likely to employ it. However with initial costs decreasing, close to 70% of credit unions surveyed, with \$200 million or more in assets, indicated plans towards putting virtual server technology in place within three years – a signal that the credit union movement is traveling at a fast clip toward the next generation of system processing and storage.¹

Why is virtualization replacing traditional architecture?

To answer that question one has to look at how traditional computer infrastructure is created and maintained. Many credit unions have applications that run on different versions of Windows or Unix/Linux operating systems. Each of these operating systems has its own set of rules, which can conflict with other operating systems; therefore each needs one or more separate servers to run on. The classic formula runs like this:

1 Operating System (OS) = 1 or more Servers/Physical Boxes

A typical data center has dozens of servers.

As a credit union adds services, which often involve new applications, it usually needs to expand the number of servers it has. This creates a dysfunctional system. Servers are added but are used at less than capacity. As any IT professional will tell you, traditional box servers take up space, suck up electricity, create a lot of heat requiring air condition/cooling, don't communicate very efficiently with one another (siloeing products and data), and require downtime to resolve bugs and other issues. All of this escalates costs and eats into both machine and human productivity.

How costly and inefficient are traditional servers?

One IDC research statistic finds that for every dollar spent on computer hardware, 50 cents is spent on energy. By 2010, it could be as high as 71 cents. There are several factors behind this. An equal amount of power is granted to idle computers as those running at full capacity, and since servers can only host one operating system, full capacity really translates into a mere 5-10% of physical capacity. At some large financial

¹ *2008-2009 Technology and Spending Report*, CUNA & Affiliates, Inc., p. 21.

institutions, server sprawl has become so prevalent that an estimated 10-15% of these servers are “ghost servers” running with no applications on them.²

One can understand why IT professionals might want a more efficient, greener, and saner approach to expansion.

A 3,000-foot high view of virtualization

Virtualization results when a server administrator employs a specialized software program that subdivides a physical server into many virtual environments (also known as “slices”). These virtual environments can function independently of one another but have the ability to draw on the resources of the physical hardware when needed. Resources are pooled/shared by all the virtual environments and are used much more efficiently.

Whereas before, the operating system ran directly on the hardware, and controlled applications like this:

APPLICATIONS
OPERATING SYSTEM
BASE HARDWARE (SERVER)

The new paradigm looks something like this:

APPLICATIONS
OPERATING SYSTEM(S)
VIRTUALIZATION LAYER
BASE HARDWARE (SERVER)

Different models for how virtualization works will be explored in the next section. For now, the reader should know that the virtual machine model, which refers to the virtual environments or slices as “virtual machines,” seems to be the choice of most credit unions at present.

In the virtual machine model, each virtual machine or VM can run a separate operating system. A computer server can then run multiple operating systems at one time without conflict. Dangerous or conflicting code is caught in “binary traps” by the virtualization layer before it reaches and impacts the hardware.

² Feig, Nancy, “Growing Green Data Centers,” *Bank Systems and Technology*, February 2008.

The virtual machine model creates several efficiencies including:

- Massive reductions in the number of servers needed overall; a process that is known among IT professionals as “rack consolidation.”
- Reductions in space and energy needed to run and cool the IT infrastructure. This translates into a smaller carbon footprint and lower energy costs.
- Vast reductions in the time needed to bring new servers and applications online. The old standard was days and weeks. Now it’s a matter of hours and minutes.
- The ability to easily switch virtual machines with functions or applications heavily in demand over from one virtual machine host to another to avoid overloading, slowdowns, or a system crash.
- Significant decrease in time needed to switch over servers for disaster recovery.
- The ability to run both test and production modes of an operating system on the same server. Developing and testing can be done without interruption to regular systems.
- The ability to switch systems from one virtual machine to another so that hardware repairs can be made and patches applied without system interruptions.

Table listing approximate server reduction

Credit Union	Location	Asset Level	# of Virtual Server Hosts	# of Physical Box Servers Eliminated
Heritage CU	Madison, WI	\$153 million	2	16
Deer Valley CU	Phoenix, AZ	\$250 million	2	11
California Coast CU	San Diego, CA	\$1.8 billion	4	27
Mid-Atlantic Corporate FCU	Middleton, PA	\$3.5 billion	8	100

This table is a snapshot of statistics provided by credit unions interviewed for this paper. Suffice to say, the average number of virtual machines that one virtual server can host can be 12 or more depending on the processor, so expansion of physical servers occurs at a much slower rate.

When CUNA & Affiliates switched to virtualization, it was able to reduce 90 servers down to about 4 or 5, according to David Macintire, former director of information technology architecture. In addition to savings in hardware costs, Macintire says, “It

also saved us a large amount of money in power directed toward cooling and battery backup. We have an enormous UPS (uninterrupted power supply) and when we replace that, we can probably go with something smaller. So there is a huge cost savings, not initially, but going forward, we'll see that benefit."

Since just under half of all credit unions are small credit unions, we should point out that virtualization can be outsourced to a trusted and reliable third party. Carl Barlow, director of software architecture for Symitar, is quoted as saying, "For small credit unions it may be possible to put multiple credit union systems on the same server."³

How Does Virtualization Work?

For those who haven't read any past articles on virtualization and who may not have an IT degree or background, let's discuss basic virtualization models.

Virtualization is based on a host-guest relationship. The server is usually referred to as the "host" and the virtual environments are called "guests." Guests are kept separate from each other through logical partitioning or subdivisions. By virtue of their programming, each has no knowledge of the existence of other guests, although as mentioned before, they are allowed to draw on the resources of the host. It's rather like a five star hotel for celebrities, where guests stay in their rooms and hatch deals while the front desk sees to all their needs.

"Each server that's not virtualized, when it's running, is running in the memory of that server," clarifies David Macintire, regarding regular box servers. "Virtualization isolates the [virtual] machine in its own separate piece of memory. VMware [a virtual machine software program] takes that bigger server with all the memory and chops it up into little pieces to give to each of the virtual servers. Each is separated in that way. As I understand it, there's no known cross-contamination or known vulnerabilities between servers."

The Virtual Machine Model (Full Virtualization)

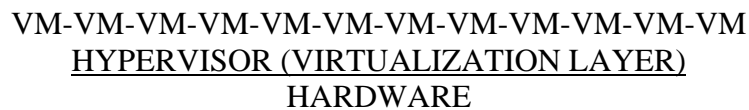
The virtual machine model allows each guest to run on its own operating system without reference to the host's or any other guest's operating system. For communicating with the host, each guest is assigned a name (think hotel room number). Of course each of the virtual machines still needs varying amounts of processing speed, memory, and other resources from the host hardware. For instance, let's say the credit union's call center is experiencing high volume and needs extra juice from its Citrix servers for processing member requests.

Each VM is tied into a virtual machine monitor (VMM) also known as a "hypervisor" and located within the virtualization layer. The hypervisor is alerted that the Citrix server

³ 2008-2009 *Technology and Spending Report*, CUNA & Affiliates, Inc., p. 21.

needs more resources. The hypervisor draws upon the hardware's pooled resources and responds accordingly.

Using the hotel analogy again, the host server's hardware would be the foundation/basement, and the hypervisor would be the front desk attendant on floor one. The virtual machines sit isolated from one another on the upper floors. This is one way to conceive of it:



Today's computers also employ ring security – assigning privileges, in the form of access to the hardware, to the most trusted systems (usually operating systems) and limiting access from the least trusted (user applications).⁴ In a traditional server, the operating system is assigned to ring 0 and applications are assigned to ring 3. In full virtualization, the hypervisor is assigned to ring 0, guest operating systems (a.k.a. VMs) to ring 1, and applications to ring 3.⁵

The virtual machine model is the most popular model used by credit unions today. This is due largely to the predominance and competitive advantage enjoyed by the early developer, VMware. One statistic shows that VMware controls 89% of the current market.⁶ VMware has been a niche virtualization software developer since 1998. It has a relatively long history and a large number of clients. In comparison to other players who have recently entered the market, a general feeling among some IT professionals is that VMware has been around long enough to work the bugs out of its programming. A second reason for VMware's dominance is that many credit unions already have configurations that include Cisco and EMC hardware, which are compatible with VMware.

The Paravirtual Machine Model

The paravirtual machine model differs from the virtual machine model in that the hypervisor modifies the guest operating system's code (kernel). This modification is often referred to as "porting" and provides a communication interface. The guest may

⁴ For a more in-depth explanation of ring security, one can read Wikipedia's article at [http://en.wikipedia.org/wiki/Ring_\(computer_security\)](http://en.wikipedia.org/wiki/Ring_(computer_security)). Last accessed on June 19, 2009. Ring 2 by the way, is usually where device drivers are assigned.

⁵ *Understanding Full Virtualization, Paravirtualization, and Hardware Assist*, online white paper by VMware, pp. 3-4. Available for free on VMware's website, www.vmware.com. Last accessed on June 13, 2009.

⁶ See "Server Virtualization News: Virtualization users remain true-blue VMware adherents," by Bridget Botelho. Article posted on http://searchservvirtualization.techtarget.com/news/article/0,289142,sid94_gci1357043,00.html#. Last accessed on May 25, 2009.

request assistance from the hypervisor, via a “hypercall,” in working on standard items like interruptions of data packets for processing—something it would labor to do on its own in a virtualized environment. Since the operating system is working directly with the hypervisor, the need for binary trapping of code is reduced, and speed/performance is increased.

Using the hotel analogy again, in paravirtualization, the virtual machines are aware of the hypervisor and rely on it. They have the equivalent of a special red phone, hypervisor-specific code, to make the connection. The hypervisor in turn gives out special instructions to assist the virtual machine with routine tasks. Some versions of the paravirtualization place the hypervisor right above the hardware, the guest operating system in ring 0, and applications in ring 3.⁷

APPLICATIONS
OPERATING SYSTEM (Hypercall-enabled)
HYPERVISOR (VIRTUALIZATION LAYER)
HARDWARE

Gregory Albano, CIO of Deer Valley CU explains paravirtualization in this way: “In paravirtualization, the OS or operating system works with and is aware of the hypervisor. It has the advantage of improving performance due to reduced virtualization overhead. The OS needs to be modified in these situations. In a full virtualization scenario, [virtual machine model] the OS is not aware it is being virtualized and thus needs no modification.”

Adds Bob Frank, senior vice president of information systems for Mid-Atlantic Corporate FCU, “Full virtualization may result in a minor performance hit to the virtual server. However, paravirtualization methods are still being developed and thus have limitations, including several insecurities such as the guest OS cache data, unauthenticated connections, and so forth.”

Since technology and software advances can sometimes occur very quickly, paravirtualization may improve in a few years time to be a viable competitor with full virtualization. An in-depth, complex comparison of different paravirtualization products can be found in Tom Henderson’s and Brendan Allen’s January 12, 2009 *Network World* article, “Citrix, Novell make a valid run at VMware ESX virtualization crown.”⁸

OS Level Model

In the OS level model, the hosts and the guests share the same operating system, common binaries, and libraries. Each layer can be given a different level of resources, and this is

⁷ *Understanding Full Virtualization, Paravirtualization, and Hardware Assist*, online white paper by VMware, pg. 5. Available for free on VMware’s website, www.vmware.com. Last accessed on June 13, 2009.

⁸ This article’s target audience is IT professionals and may be difficult to grasp for others unfamiliar with IT terminology.

referred to as distributed architecture. Since it only uses one operating system, OS Level virtualization eliminates a lot of trafficking in requests between layers, and also allows for thousands of layers to be hosted simultaneously. The downside however, is that with only one operating system per physical server rack consolidation proceeds at a slower level. OS Level also needs strict partitions to guard against system wide failure or security breach.

APPLICATIONS (in thousands of layers)
OPERATING SYSTEM
HYPERVISOR (NO VIRTUALIZATION LAYER)
HARDWARE

Mid-Atlantic Corporate FCU prefers its virtual machine solution, VMware ESX, to an OS Level Model. Says Bob Frank; “I do not see an advantage of an OS centric solution over a virtualization-layer-based one. If anything, an OS Centric solution has a disadvantage in that a hypervisor is smaller and runs on the bare metal. You have no large operating system [no virtualization layer] getting between the virtual machines and the hardware. In our system, the VMware ESX software is the hypervisor and it runs on the server essentially providing the base operating system for the box. The Windows Operating system then runs on top of the ESX.”

Storage and Desktop Virtualization

The virtualization concept also extends to storage area networks (SANs) and managing networks of thin client PCs (desktop virtualization).

The SAN is a high-speed network that brings together disk arrays from different vendors into a central location – pooling resources to manage and control memory for optimal efficiency. The need for physical server storage is again reduced. With more compact as opposed to spread out storage allocation, data retrieval and processing is faster.

Storage area networks are also a vital component in synchronous and non-synchronous mirror backup for business continuity and disaster recovery. Virtual machines can be reduced to a flat file at a primary location’s SAN, sent via Fibre Channel switches or high speed network routing to a secondary location’s SAN and replicated.

David Macintire recommends getting a SAN from a vendor that has local service. Many servers are now put on one SAN, so you need very quick turnaround on service calls. Four-hour response/turnaround is one reason his department chose an EMC CLARiiON as its SAN.

Desktop virtualization occurs more often than not when credit unions want to replace heavy desktop PCs or “thick client” PCs with “thin client” PCs. Thin clients, which are cheaper and run off a network for input and output, have a number of advantages including better security, lower energy costs, and a longer life span on average. Depreciation costs tend to be lower--desktop computers lasting around 3 years and thin

clients about six. Thin clients also run faster depending on how many are tied to a virtual machine.

Desktop virtualization reduces or eliminates the need to travel to a branch to perform maintenance or load up new applications. Instead thin clients are given software to access the network and use applications remotely from a central location.

Tinker FCU in Oklahoma City uses desktop virtualization and thin client PCs for its telecommuting network (see illustration). Sensitive data mirrored from the credit union's central servers is "painted" on the thin client's screen instead of being downloaded to its hard drive. Home-based member service representatives key in information, which is, transmitted via a virtual private network to a secure server.⁹

"Both VMware and Citrix/XEN software provide mature virtual desktop capabilities which can make the decision for moving to a thin client architecture much easier in either of these virtual environments," says Bill D'Camp, IT manager, Honda Federal Credit Union.

Macintire cautions credit unions to think about the overall cost. Consider and find out how many thin client PCs can be tied to a virtual machine at optimal speed. From there, calculate the cost savings and then deduct further investment in number of servers needed.

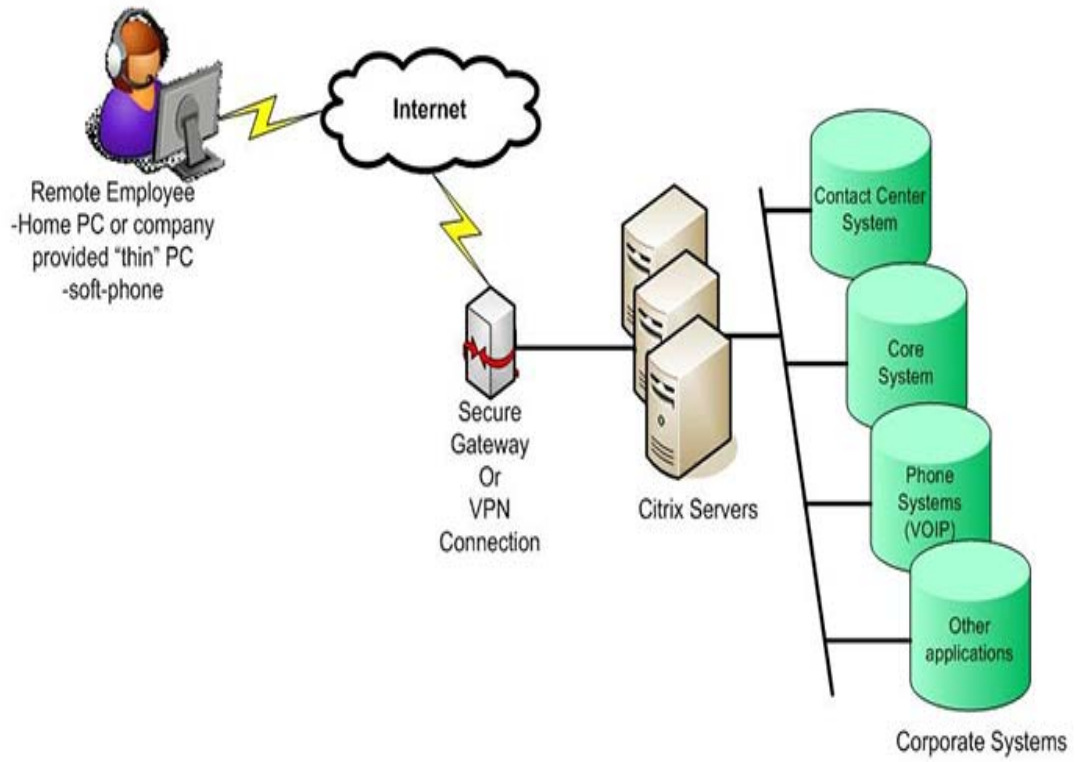
For instance Macintire says, "You have an \$800 desktop and you're going to replace it with a \$200 thin client. That's a \$600 savings, but you have to take that \$600 and put it into servers. How much of that \$600 savings per desktop is going to get chewed up by server hardware? You have to keep those things in check and make sure you're not causing more expense than you intended."

CUNA is now investigating the parameters of desktop virtualization before it heavily invests in an actual configuration. "We've heard that you can get as many as 8-10 thin client PCs per processor," Macintire observes. "Some people have said you can get as many as 20 per processor. Right now, it's hard to figure out without testing what the optimal number is so we get the speed, performance, and workstations per server to make it worthwhile."

⁹ A full profile of Tinker FCU's telecommuting system can be found in the author's 2009 Technology Council paper, *Telecommuting in Today's Environment*, available to CUNA Council members.

TFCU

Tinker FCU Remote Computing Configuration



Heritage CU – Madison, Wisconsin

Heritage Credit Union has \$166 million in assets, 7 branches in addition to their corporate location, and 3 IT staff, all of whom are cross-trained on and have responsibility for Heritage's virtualization infrastructure.

Reasons for Going Virtual

Heritage began its journey to virtual in 2005 and cut all users over on December 9th of that year. "We had a pretty small server footprint," says Richard Borden, IT director and system administrator. "We were on Novell, which for us was really a single box. We had reason to fit a lot of change and upgrades and saw the advantage of advancing to Windows and Active Directory. At the same time, we wanted to bring on more services to benefit the credit union."

However, the big driver, Borden indicates, "was to get thin clients out to the branches [and engage in desktop virtualization]. Some of our branches are four hours away, and we saw advantages to going with thin clients."

Thin clients allow one to publish or transmit applications for use to a dumb terminal as well as get the client skinny at the user level, says Borden. This improves security and reduces bandwidth needs and energy costs. It also gives the system administrator the ability to manage everything remotely either from a central location or a laptop.

But in moving to desktop virtualization, Heritage's planning circled back as to how to handle the server hardware. Says Borden, "We went from thin clients to Citrix and Citrix means Windows and Windows means Active Directory..."

The whole equation raised the issue of whether to add a whole rack of servers for each operating system or go virtual right out of the gate before even purchasing a server. "We anticipated the 'pizza box' deployment problem and actually leap-frogged it," says Borden, who points out that at the time, going virtual was quite ahead of the normal curve given Heritage's size and budget.

Hardware and Software

During implementation, Heritage's Novell server migrated into two VM server hosts, which today house 16 virtual machines. Recently, the credit union updated its host hardware to IBM 2-way quad cores, allowing up to 30 or more virtual machines on each host if needed.

This is handy for accommodating an exponential number of new applications premiering on the market without having to add physical boxes. The time to bring something online has decreased to a fraction of what it was with traditional hardware. "For the cost of a Windows license, you can spin up a virtual server and have one ready in an hour or two with zero impact on your data center," says Borden.

All production systems, including critical ones like loan origination, run on virtual machines. The exception is the core system, which runs on a standalone IBM pSeries and AIX, a Unix variant that doesn't work well virtualized alongside other applications' operating systems on the same VM host machine.

There are also little odds and ends servers that Borden still has as physical boxes. "In a couple of cases, it's a matter of leaving a legacy platform on the old physical box and looking to virtualize it during the next upgrade cycle. In the example of the imaging server, it's a case of the application having the constraint of requiring a physical SCSI interface to our optical jukebox," he explains.

Factors in Vendor Choice and Start-up Costs

In 2005 when Heritage CU was considering the virtual option, VMware was the only mature vendor in town. A business partner of Borden's had a deep knowledge base regarding the application, says Borden, and this also partly influenced his decision.

Heritage has a long history with IBM hardware and stuck with the company through virtualization. Borden remarks that data center management is easier when dealing with similar equipment and one maintenance contract. He says, "If you do need service, you see the same face walking in the door. Frankly, I think IBM service is excellent, and I enjoy running the IBM gear."

Initially, Borden had a budget of \$200,000 to cover nearly everything including technical consulting, the VMware hosts, the VMware software, Fibre Channel switches, a handful of thin client computers for the first wave, Window licenses and last but not least, the storage area network (SAN). "To go from nothing to really something, that's not bad at all," says Borden regarding the expense involved. "Its difficult to measure recovery in terms of cost because we came from something dissimilar and virtualization launched us into a different server room environment and infrastructure."

When Borden compared the costs of getting all servers against the VM package, the item that kicked the ball past the goal posts was inclusion of a storage area network, a vastly superior alternative to ordinary storage which Borden believed initially beyond the credit union's budget. "To really leverage and optimize the idea of virtual machines – separate it from the physical storage and have portability and disaster recovery option—the SAN is the way to go," says Borden. "Because then everything is in one spot – archives optical imaging, e-mail, etc."

That includes the documents and e-mails from everyone's thin client PCs, which enhances security by allowing employees to work from a remote laptop or home desktop without compromising data.

To back up the virtual machines, the credit union uses Vizioncore vRanger Pro, which reduces each VM to a flat file. It's a very cost-effective application, and Borden highly

recommends it. He's also very big on NetApp (Network Appliance) as an alternative to EMC. "You get a lot for your money in a box. All the features are included, and you just purchase licenses for the features that you want and then each is turned on."

Borden is pleased overall with the streamlining potential of virtualization. "What we would have ended up with if we hadn't virtualized would have been a lot of siloing for applications and storage along with redundant licensing expenses," he says. "Now when vendors come in, I tell them we're in a virtualized environment, and it makes it much easier to add server-based software."

Implementation and Maintenance

Heritage CU had the benefit of bringing in a consultant to assist with implementation. A key underpinning of transfer from physical to virtual, says Borden, is creating a master list of applications—how they work, where they work, where your media is, where your licenses are. You need to make sure you move everything over and that it runs well on a virtual server.

One also has to prepare end users for the change before the big day happens – educating them about new application icons, drive letters, and start-up processes.

Another challenge lies in getting your IT staff up to speed and cross-trained on the new system. "You don't touch and feel servers. [It's like] they sort of don't exist," jokes Borden. "You used to be able to walk into the server room and just work on boxes. Now you don't have to. In fact, you can't."

Instead, one has to go through the interface of the VMware virtual infrastructure client to monitor and access things. That's a brave new universe for most IT personnel. "It was easier for me because I lived and breathed it for months," says Borden. "But turning it over to staff to maintain and to really understand the network as it's changed was a curve, and I think it can't be underestimated."

Borden has had good experience getting additional education from a number of sources including the VMware vendor, VMPowered (located in Minneapolis), a self-employed local consultant who specializes in VM and Citrix, and an online regional users group.

Disaster Recovery

Borden explains that disaster recovery in a traditional server environment is expensive because for every physical server you typically have to have two like machines. In a virtual environment, all one needs is a secondary location with a server that can run VMware and a means to transmit VM file information (and one's data) such as a fiber optic or other high-speed network.

"It's taken us three years to follow the vision of where our new and improved disaster recovery is going to go and budget accordingly for it," says Borden, referring to

virtualization's potential impact. "We have dedicated space for a secondary site in one of our branches 90 minutes away. We have nearly completed the upgrade of our SAN to a larger capacity and current version, and we will then do replication to a like SAN at the secondary site. Next, we'll re-purpose our recently retired production hosts as failover hosts and move them to the secondary location. We will be doing snapshots and backups daily across the wire. In this phase, it will be a warm site, with data and VMs ready to fail over in the event of a problem at the main site."

Deer Valley CU – Phoenix, AZ

Deer Valley CU has \$250 million in assets, six branches, and three people staffing its IT department. According to Gregory Albano, CIO, the credit union has effectively utilized a third party, Pronet, to assist with the design, implementation, and maintenance of its virtual infrastructure.

"For us, outsourcing has worked very well," he says. "We have internal employees that handle our host system with member data. All Window servers and infrastructure is handled by Pronet. We could not duplicate the expertise we have access to under this arrangement if we tried to handle staffing ourselves."

Albano puts the cost of managing virtual machines through outsourcing as 80% of what it would cost the credit union to manage the actual hardware, and that does not even include the savings from fewer maintenance contracts. For some CUs, outsourcing may provide a long-term, cost-effective solution to entering and competing in the virtual machine era.

Reasons for Going Virtual

Disaster recovery, rack consolidation, and eventual movement into a 64-bit environment are three important reasons why Deer Valley CU decided to go virtual.

"Disaster recovery considerations were the main driving force for us," says Albano. "Combining virtualized servers with co-location facilities allows us to greatly reduce the cost of traditional disaster recovery while at the same time increasing our flexibility and uptime. "When we fully implement our co-location strategy, virtualization will be a big money saver as it will reduce the amount of rack space we need to rent."

Hardware and Software

"We added 2 virtual host servers, which eliminated 7 physical boxes then added 4 new virtual machines," says Albano. This translates into a total of 11 physical boxes eliminated through virtualization.

Albano breaks down the current configuration. "We have 11 physical servers – 2 VM hosts (with 11 VMs), 5 Citrix, 1 for voice response, 1 for MS Exchange, 1 to control backups, and 1 server that will be virtualized in phase II (for storage). We are also looking at virtualization of our Citrix farm (the 5 Citrix servers). Citrix sessions are how

our employees access all applications and files necessary to complete their jobs. Citrix also provides a method for secure, remote access. Virtualization will allow us to improve our Citrix response times, decrease physical servers even further and avoid the issues with moving to a 64-bit environment since many of the applications we count on do not work well, if at all, in a 64-bit environment.”

The operating system for each virtual host server is VMware ESX 3.0.1 standard edition that carries with it a 1-year platinum level support agreement. While the number of “slices” can vary, currently 11 VMs run on the credit union’s primary host and 1 on the secondary “fail over” host.¹⁰ “The two virtual host servers each have 4 processing cores at 2.4 GHz using AMD based Opteron processors,” says Albano. Each server houses a total of 8 drives, 2 at 72 GB for the [virtual] OS, and 6 at 146 GB. This gives us a total usable storage space of approximately 600 GB for virtual server hosting.”

Factors in Vendor Choice and Start-up Costs

“Experience and reputations were the primary driving forces for us in selecting vendors,” says Albano. “We constructed our contracts to clearly spell out responsibilities and penalties. Security is of primary importance for financial institutions and even more important in a virtualized environment since multiple systems can be breached if the hypervisor is compromised. The vendor needs to fully understand how to implement a DMZ [data management or demilitarized zone]¹¹ in a virtual environment in order to fully realize the benefits of virtualization.”

He stresses that it’s important to have a good working relationship with the vendor. “In our case, we have longstanding relationship (7-8 years), and so our vendor feels like another employee.”

Start-up and maintenance costs are usually in direct proportion to the scale of your environment, advises Albano but points out that return on investment can be measured relatively quickly after implementation. “We saw an immediate 30% reduction in management/maintenance costs due to fewer boxes to maintain.”

Implementation and Maintenance

Planning is essential in the transition to a virtual environment. “As a result of many hours of planning, our transition was very smooth with little or no noticeable impact on employees or members,” observes Albano. “Our biggest issue to date is a small performance hit when transferring large files because we have not yet implemented our SAN (storage area network). A key best practice is planning your environment, leaving room for growth, and if at all possible, implementing virtualization and storage or SAN at the same time.”

¹⁰ A fail over host is a server used as a backup for system recovery during crashes or failures.

¹¹ A subnetwork that interacts with outside third parties utilizing external services such as e-mail. The DMZ acts as a layer of security so that critical systems such as an e-mail server or LAN cannot be breached or tampered with. Often the DMZ uses firewall technology.

California Coast CU – San Diego, California

California Coast CU has \$1.8 billion in assets and 26 branches. Currently, two of its 19 IT staff are assigned to virtualization and server maintenance.

Reasons for Going Virtual

The credit union pursued virtualization for a number of reasons, according to John Elington, IT systems engineer. These include:

- Reducing server hardware and associated maintenance costs (going from 27 physical servers to just 4)
- Reducing electrical and cooling costs and rack space requirements
- Providing rapid build for new server requirements
- Taking advantage of a SAN (storage area network) to accommodate virtualized server storage requirements as well as the ability to move a virtualized server from one hardware platform to another without interruption of service.

In addition, Elington says that virtualization is critical to meeting fluctuating resource demands and provides for continuity of business. “Our ability to quickly implement a new server requirement in approximately 30 minutes allows fast turnaround to meet demands. In addition, server virtualization is integral to our disaster recovery plan. Our virtual server platform is installed in a remote facility with the ability to load an instance of a guest OS (operating system). VMware’s disaster recovery option, Vmotion, in conjunction with the SAN (storage area network), is also being implemented.”

Hardware and Software

California Coast CU employs HPGL380 servers (or equivalent) at maximum memory and utilizes NICs [add-on card network adapters]. It uses VMware V3.5 to perform virtualization on two virtual host servers. Elington highly recommends both vendors.

The credit union has limited the number of virtual machines or “slices” on each of its four host servers to 12 and has plans to implement 2 additional VM host servers in the future.

Factors in Vendor Choice and Start-up Costs

“Startup and maintenance costs for going virtual are directly related to the hardware platform as the physical server needs to be a high end server and fully loaded,” advises Elington. “This is still more cost effective than the equivalent number for individual

servers. Software cost and maintenance depends on the number of guest licenses required.”

The credit union also has an add-on capacity analyzer program to reduce VM server sprawl, redundancy, and underutilization. Programs like this help system administrators monitor the quickly shifting world of virtual machine creation and assignment.

Implementation and Maintenance

While California Coast CU encountered few challenges in setting up and maintaining its system, initial implementation and rollout was a slow process. “The initial VM environment was developed in a test environment and different servers/applications tested,” says Elington, who adds that one limitation was uncovered. “If an application requires a ‘dongle’¹² for security, it cannot reside in a virtual environment as a USB or parallel port cannot be restricted to use by one guest OS.”

Based on his experience, Elington has three pieces of advice for credit unions desiring to go virtual.

- Go slow in implementation. Take one server/application at a time and test, test, test.
- Ensure that the physical server has enough memory and access to adequate disk resources to support all applications being installed. Ensuring that each physical server has the maximum number of NICs [add-on card network adapters] installed will also ensure the best possible performance.
- Pay attention to the processor and memory demands of each guest OS and application. Balancing loads on multiple VM servers will be required to ensure best performance.

Mid-Atlantic Corporate FCU – Middletown, Pennsylvania

Mid-Atlantic Corporate FCU has \$3.5 billion in assets, one single location, and 21 IT employees, 7 of which are network staff that share responsibilities for virtualization.¹³ As one can imagine, a corporate credit union incorporates a lot of processing functions--acquiring servers at a rapid rate.

Reasons for Going Virtual

“The server sprawl we were experiencing was difficult to keep up with,” says Bob Frank, senior vice president information systems. “We were adding servers at a high rate and frequency. Our goal was to consolidate and support less hardware. The driver behind this goal was cost avoidance in terms of staff expansion as well as floor space in the data

¹² As defined by Bill D’Camp, a dongle is an item, such as a USB device, that is attached to a system to validate the system’s license to use a particular software product.

¹³ Linda Lingle, network services manager, assisted Bob Frank, senior vice president information systems, with information for this case study.

center and cooling costs.” Frank says that since implementation the amount of hardware on maintenance has been reduced and the data center’s footprint cut by more than half.

Hardware and Software

“The selection of Dell hardware for our virtual environment was an obvious choice based on our long-term standardization on Dell servers,” observes Frank.

In initial implementation using VMware ESX 3.5, Mid-Atlantic Corporate was able to virtualize 100 production servers on to 8 Dell 2950 servers, running approximately 12 VMs per physical server. They have since expanded that number to 125 VMs on 11 physical servers, which includes a few Dell R900s.

Another essential part of Mid-Atlantic Corporate’s virtual implementation and strategy, was its storage area network or (SAN). Currently it utilizes an EMC CLARiiON Family Storage Area network with Cisco Fibre Channel switches. The speed of this network has played a vital role in the in the efficacy of the credit union’s disaster recovery strategy, which will be discussed later.

Factors in Vendor Choice and Start-up Costs

Frank has valuable advice for credit unions on the road to purchasing and implementing virtual machines. “The primary things we looked for in a vendor included company stability, market share, and references. We have not discovered any glitches from VMware. As with any other technology or software provider however, such as Microsoft or Oracle, it would be very difficult to hold VMware accountable or liable for errors in programming that would have an impact on member data. It’s the customer’s responsibility to test and ensure that the product is suitable for the purpose for which it is being purchased.”

Putting together an estimate on the start-up and maintenance costs for virtual infrastructure can be difficult. Says Frank, “There are so many variables that need to be considered, such as whether a SAN (Storage Area Network) is in place or is needed and whether existing server hardware can be re-positioned to serve as a host for virtual machines.”

Within such a calculation, one must consider the costs avoided as an offset. These include energy and expansion costs of adding more physical boxes as well as hiring additional IT personnel.

Mid-Atlantic Corporate was able to train existing IT staff to handle the virtual machines. “We actually contracted for some professional services to do hands on training during the planning and implementation and this worked out very well,” says Frank. “When we began the actual P2V (physical to virtual) process our team was well equipped to support the environment.”

Implementation and Maintenance

For the network employees responsible for the VMs' upkeep and that of the host servers, training is always ongoing. Frank is happy to share his staff's experience and wisdom about the process. "We have been learning the ESX environment and experienced some bumps along the way," he admits. "We started with a new storage area network and new switching equipment, which took some time to learn."

"The physical to virtual migration was smooth," says Frank, "although we learned not to virtualize existing domain controllers. We also found out it was better to migrate Microsoft SQL Databases to new virtual servers and not use VMware's P2V (physical to virtual) tools. Otherwise the P2V tools worked great for the majority of our machines."

"Transferring a VM from one physical machine to another is seamless and happens when the Virtual Center server determines that resources are scarce and recommends a VM be moved to another host. This is [when we use] the High Availability and DRS options available in VMware called VMotion. With VMware, there is never a case where "bleeding" of one VM to another can occur. Each machine is essentially a VMDK file (virtual disk file) that is stored either on the ESX server or on shared storage such as a storage area network. For VMotion to work, the VMDK file must be on shared storage such as storage area network or network attached storage."

Overall Frank and his staff have been pleased with the results. "Our performance was greatly improved as we had been running on hardware that needed to be replaced for sometime," he says. "We have had minimal impact to any database or other high volume systems including Microsoft Exchange. We did find out that the ports on the Ethernet switch tied to our ESX servers had to be in the fastest backbone channel we could get to support all the through put."

Frank encourages credit unions to be honest about what can be virtualized and what can't, but adds that his staff has found little that can't be virtualized. There are also new issues raised by going virtual. "We can now deploy a new server in about 30 minutes," he says. "This is great, but it also raises issues with user departments about cost and realistic expectations on delivery of new systems."

As far as security is concerned, Frank recommends looking into securing the host machines that run the hypervisor and adds, "Currently, we are investigating the possibility of intrusion prevention systems on the ESX servers."

Impact on Disaster Recovery

As mentioned before, Mid-Atlantic Corporate implemented its virtualized server environment on a storage area network (SAN). Frank describes how this impacted the credit union's disaster recovery strategy. "As part of our virtualization implementation, the SAN was physically duplicated at our secondary location and a high speed point to point data line was installed between the locations to replicate all data on a real time

basis. This replication includes all of the virtual machines. We have physical servers in place at the secondary location that can bring up the virtual machines in a very short time. This has been tested multiple times and the results have been good. We can bring up all our virtual servers in under 2 hours --a huge difference from the 2 days it would have taken to restore from tape. We have learned and improved the process with each test.”

Desktop virtualization is also on the drawing board for Mid-Atlantic Corporate FCU and will provide additional benefits in its disaster recovery scenario. Frank says, “Our plan is to eventually store all virtual desktops on the SAN or a Network Attached storage device and replicate all virtual desktops to the secondary location.”

A Few More Pieces of Advice – David Macintire

In the introduction, we talked with David Macintire of CUNA & Affiliates about the virtual machine model and VMware, but Macintire also has some insight into the implementation process.

Macintire encourages credit unions to seriously consider attending a class on virtualization before embarking on the process. VMware sponsors certification classes around the country, or one can take classes from local vendors such as Inacom in Madison, Wisconsin.

A virtual environment for testing purposes will give you a base knowledge, but there are items beyond that which require sorting out. “There were some things that we learned during implementation and after implementation that we should have thought a little bit more about before,” says Macintire. “In planning what you want to do and how to get there—what servers you want to virtualize—it’s good to have a vendor that can say ‘that’s going to be easy and that’s not.’ Classes teach you some of those techniques.”

Macintire cites P2V conversion as an area where he could have benefited from more information. With new servers and those using recent software such as Windows 2003, Macintire’s staff found the process to be simple, but with older servers such as those hosting Linux or Windows 2000, there were issues.

However, the benefits of the new environment make up for all the sweat put into it. Vendors can bring in new software and virtual test environments are created and taken down with ease. “Once you make a template of a Windows 2008 server, you can make clones of that within minutes,” says Macintire. “It used to take half a day to get a new server up and running. Now it takes 15 minutes.”

In addition to direct cost savings, two additional benefits Macintire has seen with virtualization are gains in disaster recovery time and high availability. “Even though they’re not monetary gains, they are definitely improvements to the environment that we’ll be able to leverage by doing this,” he recommends.

Summary of Main Points

It's clear from listening to the viewpoints of the contributors that credit union data centers may be undergoing a radical transformation in the next 3-5 years due to the impact of virtualization.

There are a number of reasons why credit unions at all asset levels are pursuing server, storage, and desktop virtualization – focusing first on server virtualization. Chief among these is putting the brakes on server sprawl, which contributes to a mushrooming footprint and energy costs for power supply and cooling. This is a growing concern in the IT community given global warming, and a concern of credit union CIOs, given spending.

The virtual machine model of virtualization allows credit unions to place several servers, which use different operating systems, on one virtual machine host. With an average of 12 servers or more per virtual machine host (depending the machine's processor), this reduces the number of machines used by even the largest of credit unions to a handful and allows system administration to move from working on physical servers scattered about to a centralized virtual monitoring system.

Virtualization also permits the quick creation and erasure of virtual machine servers. Downtime for maintenance and testing is minimized. While it used to take an average of two days to bring online a new physical box server, in a virtual environment, a server can be brought on in a matter of hours or even minutes. This is important for two reasons – software testing and migration of data for backup and disaster recovery. Contributors cited both as major benefits of server virtualization offsetting initial costs.

Other models of virtualization, such as paravirtualization and OS Level virtualization, do exist, but our contributors had reservations as to whether they had the advantages of the virtual machine model for server virtualization and whether their developers had proven themselves within the marketplace.

VMware, which holds an estimated 89% of the virtualization software market, was well regarded. Contributors gave its software history and client base a vote of confidence. Another factor affecting their decision to go with VMware was existing EMC CLARiiON and Citrix infrastructure in their data centers; vendors both of whom VMware partners with.

Contributors provided numerous tips to credit unions seeking to pursue virtualization:

1. In the planning stages, take a class to help you define which physical box servers to virtualize, which to wait on, and which to leave as is. VMware has certification classes but so do local vendors.
2. Valuable information and support on virtualization can also be gleaned from regional user groups and their message boards.
3. Do a complete inventory of your servers, operating systems, and applications. Figure out which ones you plan to virtualize. If necessary, don't hesitate to bring in a consultant to assist in mapping out the process.
4. While many servers can be virtualized, others may have to wait or not be virtualized at all given their age and hardware constraints.
5. One of the advantages of virtualization is its testing mode. Go slowly with virtualizing applications and test, test, test.
6. P2V conversion is not as simple as vendors make it out to be. In terms of your timeline, be prepared to be patient and sweat it out. With Microsoft SQL databases, it may be better to migrate them to new virtual servers.
7. The ports on the Ethernet switch tied to ESX servers need to be in the fastest backbone channel possible to support all the throughput.
8. There is a learning curve behind doing maintenance in a virtual environment. Cross-training may take longer than expected because the concept is radically different. It may be helpful to have at least the system administrator trained by a hands-on expert and become acquainted with the system before this knowledge is transferred to others on the networking staff.
9. SANs (Storage Area Networks) and server virtualization go hand in hand. A SAN assists in reaping the full benefit of virtual servers in terms of high availability and disaster recovery options. Therefore, consider investing in a SAN at the same time you invest in your virtual servers. The cost of SANs is coming down to an affordable level.
10. If a credit union is concerned about keeping costs down and not having to worry about the intricacies of administration, virtualization can be outsourced to a third party. Make sure your vendor is someone you would consider almost a partner in terms of client history, reliability and trust, excellent online security, and good communication.

The author would like to note that while VMware was mentioned frequently as a vendor, it is not the only virtualization vendor out there. Given how rapidly software is developed, other vendors and other models of virtualization may invariably emerge in the next decade as suitable contenders to VMware. Credit unions should carefully research their options rather than yield to herd effect.

Virtualization is not without challenges, but its long-term benefits promise to curb rapid server expansion to more manageable, cost-effective levels. This is vitally important given the potential of credit unions to grow and offer new technology and services to their staff and members.

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Elizabeth D. Thompson has covered the credit union movement since 1999. Her CUNA Council white paper titles include, *Technology on the Fringe*, *Going Green – A Marketing Perspective*, *The Decoupled Debit Dilemma*, *Serving New Americans*, *Leadership and Change Management*, *Net Promoter Score in Action*, *Creating an Experience Culture*, *Microlending and Credit Unions*, *Meeting the Challenge of Preparing On-the-Job Trainers*, and *Corporate Universities*. Past credits include *Credit Union Executive Newsletter*, (now called CU360 newsletter), *Real Stories from Credit Unions*, MERIT Module, *Community Involvement*, and VAP Module, *Online Policies and Internet Use*. She is based in Madison, Wisconsin.

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