CDW PEOPLE WHO GET IT

TAKING I.T. AGILE WITH SERVER VIRTUALIZATION

A flexible and optimized infrastructure requires unshackling computing from physical servers.

Executive Summary

It's a common request of the IT department: Do more with less.

Technology teams in most organizations must respond to increasing demands to support applications and meet the evolving needs of both internal and external users. However, IT budgets have not grown proportionally – if at all, in many cases. Tech staffs must aggressively seek ways to stretch those budgets.

The technology in use also must be more agile than in years past. National and local economies have become more volatile than ever. Technological innovations in social media and mobility are changing the rules by which markets operate seemingly overnight. Natural and human-caused disasters wreak unpredictable havoc.

To help organizations survive and thrive in this environment of near-constant change, the technology they use must be able to adapt quickly to sudden shifts in application workloads.

TWEET THIS!

Table of Contents

In response to these twin imperatives of efficiency and agility, technology vendors now deliver a broad range of virtualization solutions. These tools overcome many of the limitations that historically characterized physical IT infrastructures — empowering organizations to achieve greater value from existing hardware capacity and to respond more nimbly to change.

Server virtualization is of particular importance because so much of what the IT department does depends on the capacity and performance of the servers in the data center. In fact, server virtualization is dramatically improving the performance of IT departments everywhere. It also serves as an essential step toward cloud computing, which can further increase the efficiency and agility of the IT operation.

This white paper details the current state of server virtualization and offers some practical insights into how IT departments can best take advantage of its benefits. No organization can afford to overspend on data center infrastructure that is insufficiently responsive to its changing needs. And with the right virtualization strategy, it won't have to.

How Server Virtualization Works

Not so long ago in the vast majority of data centers and server rooms, every application or service resided on its own dedicated physical server. All the capacity of each of these servers — including CPU cycles, memory and input/output (I/O) — was allocated exclusively to its resident application or service. For instance, if an app didn't utilize all of its host's capacity, the excess capacity basically went to waste.

What's more, if an app or service in such an environment started to max out some aspect of a physical server's capacity, the only option was to buy another server and then allocate it to that application or service — even if only a fraction of its capacity was actually needed. Server virtualization radically alters this scenario.

With virtualization, a layer of intelligence and automation called a hypervisor is placed between the physical server's hardware resources and its operating system. This hypervisor allows multiple virtual servers (more commonly referred to as virtual machines, or VMs) to run on a single physical server and share its CPU, memory and I/O.

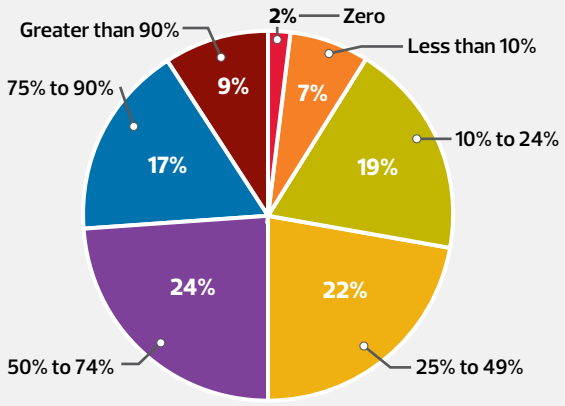
These VMs operate independently from one another. Therefore, their capacities — and even their operating systems — can vary. For example, a single physical server can run one Windows VM that consumes up to 50 percent of its physical resources and half a dozen Linux VMs, each of which only requires a small percentage of them.

In addition to allowing a physical server to be shared among multiple VMs, virtualization also makes it easy to move virtual servers between hosts. A VM is, in essence, really just a piece of code. It can run as easily on one machine as another.

As a result, a group of virtualization-enabled physical servers in a data center can be treated as a single pool of CPU, memory and I/O capacity that can be allocated flexibly to whatever applications or services need use of them at any given time.

IT Departments Rely on Server Virtualization

This pie chart shows the percentage of production servers that individual IT organizations in North America plan to have virtualized by the end of 2013.



SOURCE: *2012 State of the Data Center Survey* (InformationWeek)

When to Consider It

The broad benefits that server virtualization offers have it rapidly becoming a standard feature within the infrastructure of just about every large organization, as well as many small and midsize enterprises. But its adoption typically is triggered by one or more of the following specific conditions that threaten the IT staff's ability to meet the needs of the organization with optimum effectiveness and efficiency:

Underutilization of server capacity: Many organizations find that a large percentage of the servers in their data centers operate at as little as 20 percent to 35 percent of actual capacity. Low utilization rates mean that these enterprises won't get nearly as much value from their server investments as they could.

In many cases, organizations also have limited budgets for the purchase of new servers. Utilizing the idle capacity on those already in use is a prime driver for most virtualization initiatives.

Fluctuating workloads: Many organizations have workloads that vary widely. Sometimes peak processing demands are periodic and predictable, such as the approach of the April tax filing deadline or the beginning of a semester for colleges and universities.

At other times, fluctuations are less predictable. Retailers can't always predict sudden surges of consumer interest. Government agencies can't always anticipate a crisis that affects local constituents. Either incident could suddenly place an unexpected burden on IT capacity.

Regardless of what causes a spike, IT shops recognize that they must be able to maintain acceptable service levels for critical applications, even in the event of sudden demand surges.

Server provisioning as a process bottleneck: Organizations of all kinds find themselves increasingly dependent on technology to expand their services, bring new products to market and otherwise evolve to meet changes taking place in the world around them. Unfortunately, the time it takes to procure, install and configure a physical server can slow down the process of developing and rolling out critical IT capabilities.

As this process bottleneck becomes more problematic, organizations become interested in fast, easy and less expensive ways of provisioning server capacity to support new capabilities.

Service outages and inadequate resiliency: Hardware failures, sluggish operating systems and other technical problems also can precipitate a move to virtualization. This is particularly true if technical hiccups interfere with delivery of essential services to internal or external users. Outages spur organizations to look for ways to make their IT infrastructures more resilient without large capital investments in redundant hardware.

Of course, many organizations decide to adopt server virtualization not because of any particular crisis in IT operations, but simply because they want to continue to fully optimize the resource efficiency and agility of their data centers. But any organization contemplating a move to server virtualization should nonetheless audit its data center to get a handle on the scope of the initial implementation, as well as to determine the applications and services that most urgently need to be virtualized and craft a long-term migration strategy.

Data Center Optimization

The benefits to both the economic and operational performance of the data center lead many IT decision-makers to take a hard look at virtualization if their organizations haven't already begun migrating to virtualized environments. What's more, these optimization benefits have become available at a time when technology has taken on a greater role than ever before in how organizations meet tactical and strategic objectives. These benefits include the following:

Reduced capital spending: When an IT department must buy a new physical server every time it adds a new application or has to increase compute capacity for an existing one, hardware costs can quickly consume its capital budget.

Server virtualization can reduce capital expenditures (CAPEX) drastically by allowing an organization to leverage available capacity on existing hardware instead of buying new machines. In fact, depending on how underutilized its data center's servers are before virtualization, an organization might see its CAPEX figures for server hardware drop by as much as 40 percent.

Reduced data center operational costs: With less hardware in the data center, IT overhead decreases in other ways. Some of the biggest savings come from reduced data center cooling and power consumption. This can be particularly important in locations where there are high electricity prices or the seasonal temperature ranges are extreme.

Organizations with limited floor and rack space in their data centers also can save money by avoiding physical expansion. The IT staff will save on time and labor as well, because it costs less to generate a new VM than it does to install and configure a physical server.

An Old Idea Reborn

Server virtualization is actually an old and time-tested idea. As early as the 1960s, IBM was implementing virtualization on its mainframe computers.

The initial appeal was being able to run new and potentially unstable applications on an organization's mainframe so that it could test them in production-like conditions without jeopardizing the integrity of the system as a whole — and, by extension, all of the other mission-critical applications running on it.

With the initial advent of distributed systems, however, server virtualization seemed unnecessary. After all, each physical server functioned as a discrete, independent machine. If developers wanted to test a new application, they could just use a set of physical servers in their own lab.

But as the demands on IT departments have escalated, and as capital budgets for the purchase of additional hardware have become relatively limited in proportion to that escalation, virtualization has become not just an appealing option, but a necessity.

Reduced software licensing costs: Software vendors license their products in different ways. They are responding in different ways to the growing use of server virtualization, too.

In many cases, the structure of licenses allows customers to reap savings by eliminating per-processor costs. These savings can be particularly significant when it comes to database and OS licenses. Some software licenses also give customers the flexibility to pay for higher utilization only as needed instead of on the assumption that they require peak processing every day.

Better IT service levels: Server virtualization gives the IT group previously unattainable flexibility when it comes to supporting shifting requirements. If the workload for a particular application typically spikes at the end of the month, the data center can throw more compute power at it then and reallocate that processing muscle to other applications when it is not needed.

If a specific capability or posting on an organization's website suddenly becomes hugely popular, the data center can quickly spin up new VMs to keep it from overloading and crashing the site. This adaptability helps organizations ensure that IT services and applications perform at required service levels even as sudden, unexpected shifts occur in application workloads.

Cost-effective continuity and disaster recovery: Organizations can use server virtualization to improve their ability to maintain operations in the event of hardware failures, natural disasters and other occurrences that might otherwise threaten critical IT services. This can prove particularly valuable when physical servers are located in one or more remote locations. Essential IT services and applications can be quickly transferred to VMs running on servers in alternate locations if something imperils the main data center.

But server virtualization also helps organizations that contract with service providers for hosted recovery services too. It's much easier and more cost-effective to spin up VMs in these facilities than to maintain spare physical servers.

Combined, these benefits make server virtualization a powerful tool for any organization seeking to gain the most value possible from its IT investments.

Streamlined Development and Quality Assurance

The application development team in particular can benefit from server virtualization.

Research and development and software development organizations constantly need servers to run and test code under a variety of simulated conditions — but only for very brief periods.

Server virtualization makes it simple to provision sandbox (temporary) environments that can be torn down once a project is completed.

Supporting Other Initiatives

Although there are plenty of benefits that make server virtualization worthwhile on its own, it also complements other initiatives within an organization's broader IT strategy. These include data center consolidation, other types of virtualization and cloud computing.

Data Center Consolidation

Over time, organizations acquire multiple generations of technology. As a result, that technology is often implemented in a less-than-systematic fashion. IT teams eventually find they must manage a fragmented computing environment that can be expensive to monitor, administer and support.

Systems have their own idiosyncrasies, which means that IT staffs must perform similar tasks repeatedly across different platforms and maintain expertise in dealing with many types and makes of technology.

The problem is even worse if these assets are dispersed across multiple data centers or locations. In such situations, the IT team must either maintain staff in multiple locations or rely on remote-access tools to keep systems up and running. Organizations also wind up spending more on energy, cooling and floor space given these circumstances.

Fragmented computing environments are difficult to troubleshoot, secure and protect with appropriate data backup and recovery. The solution is data center consolidation. By consolidating diverse and geographically scattered resources in a more uniform infrastructure at fewer locations, an organization can drive down its technology ownership costs substantially and simplify IT operations.

Server virtualization can tremendously complement data center consolidation because it allows a larger number of applications to run on a smaller number of physical machines. It also facilitates workload consolidation by enabling the IT department to run different OSs on the same physical machine, both to ease management (by making changes to a single virtualized instance of an application) and to provide automated failover of threatened data and services from one VM to another.

Other Types of Virtualization

Virtualization is not restricted to servers; storage and desktops also can be virtualized.

Desktop virtualization can be done in several ways. Sometimes, a set of desktop images is stored on a central server. This allows the appropriate applications and files to be delivered to users' clients when they are started each morning. In other cases, applications and files remain on a central server while the client systems simply act as a monitor and keyboard for computing activity that occurs on the remote virtual desktop.

Either way, virtual desktops make the IT team more efficient by eliminating the need to install and configure redundant sets of files on large numbers of desktop systems. Controlling and updating desktop images from one central location cuts costs and eliminates common reasons for many help desk visits by tech support.

Storage can also be virtualized by uncoupling stored files from specific storage devices. That way, storage capacity across all devices can be flexibly allocated to applications and services as necessary.

Server virtualization dovetails with both of these other virtualization technologies. There can be a lot of overlap, for example, in how the images of VMs are managed — whether they are virtual servers or virtual desktops. And virtualized storage makes the most sense in a data center that relies on server virtualization, because both decouple files and processes from specific physical assets, which enhances scalability and flexibility.

Cloud Computing

Cloud computing lets organizations avoid capital expenditures, reduce ongoing technology ownership costs and quickly roll out new capabilities. With many cloud services, organizations have more flexibility in expanding and contracting their computing capacity, rather than being locked into fixed capacity that might be too low or fixed costs that might be too high at any given time.

By moving some processing demand to the cloud, organizations can tap a wide range of on-demand, subscription-based hosted resources. These include infrastructure as a service (IaaS), platform as a service (PaaS) and software as a service (SaaS) options.

With IaaS, an organization gets access to servers, storage, networking and other raw compute resources on which it then can build and run applications. With PaaS, a cloud provider serves up an integrated stack of firmware (the OS, database, storage protocols and other elements) that make it possible to deploy new applications and services quickly. With SaaS, meanwhile, organizations get fast access to a complete, configurable application right from their users' desktop browsers.

Server virtualization plays a key role in any organization's use of the cloud, especially IaaS, PaaS and similar services. The reason is that VMs give the organization the ability to freely move server images between internal development environments, production data centers and multiple cloud environments. In fact, the transformation of servers from physical machines into code is an elemental component in the long-term value proposition of moving infrastructure or services to the cloud.

Implementation Best Practices

Although every organization's requirements differ, certain best practices can help ensure the success of a server virtualization initiative while maximizing long-term return on investment.

Most servers can be virtualized. But some are better candidates than others, and some shouldn't be virtualized at all. So it's essential to target the right ones for virtualization. Three factors to consider are baseline resource utilization, variability in resource utilization and the compliance and security considerations.

Before embarking on a virtualization project, it is worthwhile to profile how the various applications in the organization's data center use resources on existing physical servers.

Applications that don't excessively utilize those resources (especially CPU, memory and I/O) are good candidates for immediate virtualization, because they more easily can share a single physical server with other applications. Applications that are "maxing out" resources may be best left on their own physical machine for the time being because they will require more fine-grained planning for migration.

A server also may be a good candidate for virtualization if an application's use of resources is highly variable. Virtualizing these systems eliminates the need to allocate excess physical server resources that would go unused most of the time. Instead, the additional capacity needed for peak periods can be provisioned on VMs that can be eliminated when the peak period ends, freeing those resources for other needs.

Security and compliance constraints may require that a given application not share a physical server with any others. This might be because of a need to restrict user and administrator access, a regulatory requirement regarding sensitive data associated with an application, or the fact that the cost of the server is borne by an internal or external user.

Choosing the Right Hardware

Server virtualization does not make hardware irrelevant. In fact, optimizing the underlying server hardware can improve the outcome of most virtualization initiatives substantially.

A key factor is the chipset. The popularity of server virtualization has led chipmakers to design processors that facilitate it by reducing the overhead required to support hypervisor functions. These optimized chips also streamline the sharing of resources such as network and storage I/O. By using servers with such chipsets, an organization can run more VMs per physical machine while safeguarding application performance.

Often it also makes sense to move to a smaller number of large servers. Much of the value in virtualization comes from the economies of scale that result when a greater number of VMs run on a smaller number of machines.

Network and Storage Implications

As organizations extensively adopt server virtualization, changes occur in the data center that can significantly affect other facets of the infrastructure. For example, as more VMs run in the data center and server utilization grows, network traffic also grows. The result? A data center may need to increase its server uplinks to 10-Gigabit Ethernet.

In addition, as VMs start to move around the data center to different servers to optimize the use of pooled resources, the network must be flexible to handle heavy traffic between certain servers on the same virtual LANs.

Server virtualization also affects storage. One obvious example is with direct-attached storage. Having storage directly attached to a physical server makes far less sense if the VM running the application associated with that storage could move to another machine at any time. Plus, because virtualization makes it easier to add more VMs running more applications to the environment, it tends to drive the need for bigger, faster disk arrays.

These consequences aren't always apparent in the early stages of virtualization. But any organization planning long-term adoption of virtualization should be aware of these considerations and plan accordingly.

Hardware manufacturers achieve economies of scale when they add more capacity to a single machine as well. Therefore, it makes sense to move to larger machines (those with four or more cores) as part of any virtualization initiative.

Because one of the main advantages of virtualization is the ability to move VMs across machines based on utilization and available capacity, it helps to build server pools made up of similarly configured machines. This consistency reduces the need for IT staff to double-check whether a particular machine has the right build for any given VM.

Choosing the Appropriate Platform

Organizations have several choices when it comes to virtualization platforms, and the differences between them can be significant.

First, there are licensing costs, which vary between virtualization platforms. A careful analysis of the combined cost for the hypervisors, management tools and integration utilities necessary for an organization's particular data center requirements is therefore essential.

Also be sure to look at management functionality. Virtualization vendors constantly compete with one another to develop innovative management capabilities that can maximize an organization's IT adaptability and efficiency. IT decision-makers must consider these management capabilities to select the solutions that provide the greatest benefit with the least drain on limited IT staff resources.

Take performance into consideration. Hypervisors and associated management utilities consume overhead on host machines and have different characteristics when it comes to the performance of the applications that run on top of them. It is important to factor in overhead and performance considerations when choosing a platform, too.

What about integration? Hypervisors and VMs constantly interoperate with storage, networks, applications and security resources, as well as their physical hosts. The better they integrate with these other resources, the easier it will be to automate management of the end-to-end data center environment.

Although virtualization technology is certainly mature enough to implement safely, it's still evolving in response to the changing needs of IT. So in addition to ensuring that a manufacturer's existing solution is a good fit with its current needs, an organization needs to find a partner with a vision for the future that aligns with its own goals.

Hyper-V and Windows Server 2012

In September 2012, Microsoft released Windows Server 2012, which includes the latest version of the company's virtualization platform, Hyper-V. This version features several important new capabilities:

- **Support for larger workloads:** A single instance of Hyper-V can theoretically run up to 1,024 VMs, each of which can be configured with up to 1 terabyte of RAM and can have virtual disks configured up to 64TB.
- **Smarter resource utilization:** Hyper-V provides new dynamic memory improvements that increase the number of VMs that can run on a physical host. It also offers new resource metering functions that track the amount of data transferred by each VM and new quality of service (QoS) features that let the IT team specify the minimum bandwidth available to each VM.
- **Storage enhancements:** With Hyper-V, VMs now can be integrated directly into Fibre Channel storage area networks (SANs). Microsoft has added Offloaded Data Transfer support that eases workloads on the CPUs of physical hosts.

Perhaps most important for an organization with limited budget and staff, Microsoft includes Hyper-V free with Windows Server 2012 and offers economical licensing terms for related tools.

Finally, there are cases when hosted virtualization makes sense instead of hypervisor-based virtualization. With hosted virtualization, the hypervisor sits above the physical machine's operating system rather than installing on "bare metal." This form of virtualization can be an appropriate solution in development environments, especially those in which programmers want to run multiple clients on a single machine.

Licensing, IT Operations and Tech Support

Along with thinking about how server virtualization will improve and transform the data center infrastructure (including server, storage and network hardware), an organization also must plan for the various ways it will affect other aspects of IT.

Software Licensing

The licensing of applications, databases, middleware and other forms of software was already fairly complex before the advent of server virtualization. Vendors licensed their software based on the number of named users, concurrent users, number of servers, number of processor cores and multiple combinations thereof. The challenge has been to purchase sufficient licensing to ensure that the organization pays for its actual software usage while not buying more software than needed.

Server virtualization can complicate software licensing in two ways. First, because VMs are more fluid than physical servers, an organization's usage parameters can change more easily than they could before. This means the organization easily could slip into noncompliance with its licensing agreements if the IT staff fails to exercise sufficient caution.

Second, software makers take varied approaches to software use in virtualized environments. Some freely allow their software to be used on VMs that can move anywhere across the data center. Others are more restrictive about the VMs running their software. And some don't accommodate virtualization at all.

Organizations must therefore inventory their existing software and applications so that their virtualization efforts don't end up violating the terms of their licenses or driving up licensing costs unnecessarily.

IT Operations

Server virtualization has a fairly significant effect on the way that the IT staff operates.

For instance, without virtualization, the provisioning of a new server is a manual and relatively slow process. Someone has to requisition a piece of hardware, which then must be ordered, shipped, installed and configured. All of these costs and logistics put constraints on the number of servers in the data center that must be monitored and managed.

With virtualization, on the other hand, many of these constraints seemingly disappear. New VMs can be spun up with just a few keystrokes and no immediate cash outlays at all.

The IT department should respond to this major change in operational conditions by establishing new policies and processes to regulate VM provisioning appropriately without adversely affecting the organization's new-found agility.

In addition, the IT team will need to develop policies and processes for deprovisioning VMs if and when they are no longer needed. Otherwise, organizations could start to experience VM sprawl, which can result in large numbers of unnecessary VMs wastefully consuming resources and creating potential security vulnerabilities.

Technical Support and Training

Virtualization is new territory for most IT staffs. To ensure the success of these initiatives, the staff will quickly need to gain competency in hypervisor administration, VM management tools and the effect of server virtualization on the rest of the data center infrastructure.

Therefore, organizations making the move to virtualization need a source of quality technical support to help them get started on their journey, as well as the training necessary to reduce their dependence on that support over time.

The Security Implications

One area that organizations must pay special attention to as they virtualize is security. VMs are essentially software code, and software code is inherently vulnerable to both malicious and unintentional harm.

Not only is securing VMs quite different from securing physical servers, but the typical virtualized environment contains a much larger number of VMs than nonvirtualized environments do physical machines. Simple math therefore dictates that this increase in the number of servers means a higher likelihood of potential vulnerabilities.

Fortunately, the IT team can mitigate the risks associated with virtualization by adopting proven security best practices, including the following:

Patch management: As the number of VMs in the data center grows, the tech staff must implement more reliable and automated processes for the OSs running on them. Hypervisors also have to be kept up to date with appropriate security patches. This may require the use of newer and better systems management tools.

Data encryption: Because VMs are code, they have the potential to be copied and stolen — which, in turn, can expose underlying data to theft. Encryption can play an important role in safeguarding data against these kinds of VM-based exploits. The organization may need to use encryption more

extensively than it has in the past, which could drive the use of more sophisticated encryption management solutions.

Access controls: There can be a tendency to grant system administrators full access privileges to hypervisor management consoles by default. This is not a best practice when it comes to security.

Instead, permissions should be restricted to only those privileges necessary for a given administrator to fulfill his or her responsibilities. Special care should be exercised in giving staff access to low-level file operations that allow copying and modification of VM attributes.

VM-to-VM communications: Physical machines communicate with one another over the physical network, where conventional monitoring tools readily detect anomalous traffic. VMs residing on the same physical host, on the other hand, communicate via virtual network connections within that host that may be invisible to these tools.

To safeguard the data center environment against exploits that propagate from VM to VM, the IT team may have to create "mirror ports" that allow appropriate monitoring of this traffic.

Logging and auditing: Over the years, many organizations will have developed mature auditing and logging capabilities across their conventional infrastructures. These capabilities are crucial for alerting IT and security staffs to anomalous activity and for performing forensics if a breach occurs.

The creation of similar capabilities for hypervisors and VMs may take some doing — or require the use of third-party solutions — because the native utilities provided by virtualization vendors may not be as complete or mature.

These and other additional measures required to secure virtualized environments involve new work for the IT staff, but they typically don't add a lot of cost to the budget. With proper guidance, any organization can effectively mitigate most new risks associated with virtualization. The long-term benefits of this technology far exceed the additional diligence it requires.