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TECHNOLOGY ASSESSMENT

The Impact of Virtualization Software on Operating Environments

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IDC OPINION

There are precious few technologies that really create something remotely close to the overused term *paradigm shift,* and it's even more rare when those technologies actually sweep across the industry in a few short years. Virtualization of system resources aboard x86 servers is one technology that has the distinct potential to really change the dynamics of the industry in many ways as it quickly becomes a de facto component of modern computing. Highlights of our research include:

- Virtualization should be recognized as a disruptive force that will significantly change the rules of the game for operating system vendors. The ability to support low-cost "software appliances" is just one of the new dimensions that will emerge over the next 24 months. Other use trends, such as the ability on the part of end users to create a rapid replacement scenario for operating systems supporting low-value applications or workloads and the ability to ship an operating system and its associated workload to a remote server at a service provider, create truly market-changing challenges — and opportunities — for vendors.
- Where there is change and challenge, there is also significant new opportunity. Creating short-life or completely disposable operating systems could be disruptive to the traditional business model. How traditional vendors respond to these new form factors will separate the long-term winners from the long-term losers.
- The impact is not just to the operating system layer. Snapshotting and staging system images across a network connection, instead of backing up or replicating a given environment, can potentially change how end users approach high-availability and disaster recovery planning.
- System management vendors will find they are no longer managing physical servers but physical servers *and* virtual servers. The management of the physical servers and the virtual servers will diverge in interesting ways. Managing physical servers will continue to focus on allocating and monitoring system resources and tracking impending hardware failures, while virtual servers will receive allocations of system resources but also must be tracked as they are redeployed from physical server to server, or as resource requirements expand or are consumed by other guest operating systems.
- This is not just a server phenomenon. There is also significant potential for disruption in the client operating system space, both through the inclusion of virtual machine software aboard client devices and through the advent of virtually hosted client operating environments — housed aboard remote servers and accessed through inexpensive mobile or thin-client devices.

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IN THIS STUDY

This IDC Technology Assessment presents IDC's assessment of how virtualization technologies are impacting and will continue to impact operating environments and the operating environment market over the near and longer term.

SITUATION OVERVIEW

Introduction

It's been said that everything old is new again, and nothing could be more true than that with system virtualization. The introduction of virtual machine and hypervisor technology aboard x86 server hardware is arguably the most exciting development to emerge in years, but this technology, however new it is aboard the x86 server platform, is hardly new.

Virtualization and system partitioning have existed for decades aboard mainframe systems from IBM running OS/390, z/VM, and z/OS and, more recently, aboard IBM's iSeries and pSeries platforms as well as on HP's HP 9000 and Integrity product lines. What's new is the concept of bringing this virtualization technology to small- and medium-scale x86-based servers.

There are lots of compelling reasons for using system virtualization software. On client systems, the ability to run multiple operating environments allows a user to support application workloads that are only available for an operating environment other than the primary environment the user wants to use. For instance, a Linux user can utilize virtual machine technology to support a Windows environment along with Microsoft Office on a system whose primary job is that of a Linux workstation.

For developers and support personnel, virtualization software provides the ability to create test- or scenario-based configurations and experiment with and/or destroy them, then discard the instance and recreate them in minutes — all without having a dedicated test system or disrupting the primary operating system on the machine.

However, it is aboard the x86 servers — not aboard clients — where virtualization will be broadly deployed first. We believe that the deployment of virtualization software is nearly a given for next-generation servers, especially for those using 64-bit processors and modern operating system software, which are likely to have built-in virtualization capabilities. The result is a potentially cost-saving scenario for existing infrastructure, and for new deployments that can be architected to leverage virtualization.

Technology Positioning

Virtualization is changing the landscape of the x86 IT world as we know it. Virtualization has made every vendor up and down the software and hardware stacks consider the impact on the architectural design of its product and the go-to-market model it uses. Further, deployment scenarios and, of course, the licensing and use

rights become a key discussion point for many products. Looking ahead, we expect that virtualization will become an integral element of all next-generation operating systems, and for next-generation server hardware. Even client systems may see virtualization layers incorporated into their base system design in the future.

Calendar year 2006 will be remembered as the pivot point of this shift, as virtualization technologies are now being tightly integrated into operating system products for the x86 server platform. The first operating system product to emerge with integrated virtualization came from Novell with its SUSE Linux Enterprise Server 10 product, which incorporates open source XenSource technology into the Linux distribution. Red Hat Enterprise Linux 5, due toward the end of CY06, will also offer integrated XenSource technology.

Microsoft, the largest player in the x86 operating systems playing field — and the largest, most influential vendor — currently projects availability of its Viridian hypervisor technology to be not more than six months after the release of Windows Longhorn Server. Given the current time line for the Longhorn wave of products, it is expected that Viridian will become available during the first half of CY08.

While these new hypervisor technologies begin to establish credibility and users become familiar with them, VMware already has a well-established solution in place in the industry. Up until now, it has had an edge not only in performance but also in manageability.

With the transition over to hardware-assisted virtualization, performance will improve for all virtualization solutions, and the software tools that provide virtualization services or manage them, including VMware's ESX Server and the company's VMware Virtual Infrastructure 3 (VI3) suite, will continue to mature.

Types of Hardware Virtualization

Several different types of virtualization schemes are relevant aboard x86 server hardware. This collection of solutions includes the use of a pure software layer that creates the illusion of a hardware architecture (a virtual machine software layer). Software virtualization must intercept some operating system calls and service those using an emulation of underlying hardware resources, leading to higher overhead. One solution to the growing problem of performance degradation associated with pure software virtualization is the use of so-called paravirtualization.

Paravirtualization is similar to pure software virtualization, but it offers lower overhead to the guest operating system. The key difference between software virtualization and paravirtualization has to do with the support for a limited number of privileged instructions that are used by an operating system to control hardware functions.

Software virtualization traps these privileged instructions dynamically and handles them appropriately through emulation, while a paravirtualized environment mandates that the privileged instructions be replaced or trapped on a static basis. This is accomplished by using a specialized version of the operating system kernel with these calls already resolved or replaced in a paravirtualized host environment.

Some customers are disinterested in a paravirtualization solution because of the requirement of kernel modification — which may be accompanied by recertification or compliance testing and verification of entire software stacks due to regulatory requirements. Paravirtualization is especially problematic with existing Windows operating systems because modification of the kernel must be done by Microsoft, which is typically not interested in creating derivative versions of the Windows operating system due to the support requirements.

Future Microsoft operating systems, including Windows Vista, will include what Microsoft calls "enlightenment" — a modification that enables the operating system to function natively (directly on silicon), or in a paravirtualization mode on top of a virtual machine or hypervisor. This "enlightened" kernel will require no modification or attention from the user based on the deployment scenario.

From a pure performance perspective, paravirtualization would offer a performance edge compared with pure software virtualization, while from an ease-of-configuration and compatibility perspective, pure software virtualization is easier to adopt, particularly for legacy operating systems. However, absolute performance issues aside, the specific type of virtual machine solution being used on a server will be largely invisible to users who are interacting with application software.

Hardware Innovations

Next-generation x86 virtualization will take advantage of hardware assistance being built into processors by chip vendors, in the form of Intel's Virtualization Technology (VT) and AMD's CPU virtualization technology (formerly called Pacifica).

Neither Intel's VT nor AMD's CPU virtualization technology eliminates the requirement for virtual machine technologies from Xen, Microsoft, SWsoft, VMware, or others, but rather these technologies make the virtualization enablement easier to accomplish without requiring paravirtualization for better performance. The processor vendors accomplish this by changing the relative privilege where the virtual machine software layer is installed, enabling the operating system layers to continue to use the privilege level normally utilized by the operating system.

It should be noted that Intel VT and AMD's CPU virtualization technology will be, in general, solutions for customers moving forward — although in some cases customers with existing systems can enable these new virtualization solutions through a firmware upgrade. Nevertheless, until customers have a critical mass of systems that incorporate Intel VT– or AMD CPU virtualization technology–enabled processors throughout their organizations, there will not be a huge market for virtualization software that leverages these hardware technologies.

New Technology Drivers and Business Goals

The adoption of virtualization technology within organizations typically follows a cycle of low-risk to mission-critical solutions, producing a corresponding low-value to high-value return to organizations. IDC research has found that typical corporate adoption moves through an adoption continuum of uses that includes:

- Test and development
- Server consolidation

- High availability
- Disaster recovery
- Capacity planning/utility computing/dynamic IT

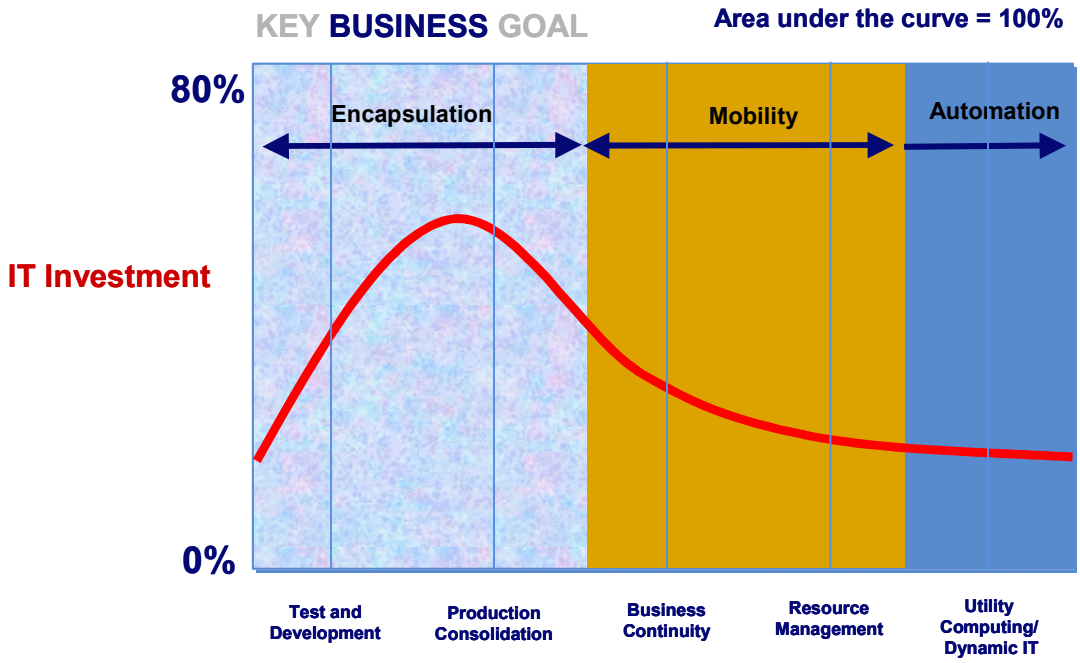
Accordingly, we see virtualization as not a binary shift or a one-time investment to solve a single problem or set of problems. Instead, it is a solution that will stretch across a continuum of customer requirements. Early adoption of x86 virtual machine software has largely been a solution aimed at server consolidation, but moving forward, the range of deployments will broaden significantly.

Figure 1 shows IDC's view on how customer adoption of and investment in virtual machine software is distributed at the time of this document's publication, and how that adoption maps to business goals of the adoption.

The curve shown in Figure 1 is a snapshot of customer investment profile based on the use scenario. As implied by the curve in this figure, we believe the spending on virtualization software for test and development has peaked already, while the spending on server consolidation is likely nearing its high point in late 2006 and early 2007.

FIGURE 1

Virtual Machine Software Investment Continuum



Source: IDC, 2006

Meanwhile, spending on more advanced uses of virtualization software, including that for business continuity, resource management, and utility computing, remains at a lower investment level. Over time, we expect the peak of this curve to move to the right, as primary spending shifts with the increasingly mature uses of virtual machine software.

Today most organizations adopting virtualization technology on a broad scale are still in the middle of consolidating the excessive server sprawl that took place over the past decade. Encapsulating multiple physical servers onto a single consolidated server through virtualization enables cost and resource efficiencies, including a reduced consumption of physical floor space in a datacenter.

Today's use of virtualization technology allows IT professionals to automatically manage the resources of the physical server to efficiently support multiple operating systems, each supporting different applications.

In an enterprise this could mean consolidating hundreds of servers to as few as 10–20% of that total, which could reduce hardware management and service requirements up front and, over time, reduce software management loads. As this trend propagates downward into the small and medium-sized business (SMB) market, it could mean a need to buy one or two servers to achieve the functionality previously configured through multiple servers.

Longer term, the potential to move into business continuity, and after that into resource management and dynamic IT, offers customers an ongoing value proposition for the adoption of virtualization technology. Most organizations need to begin at the left side of this continuum to develop in-house expertise, prior to moving to more mature use scenarios to the right of the continuum.

FUTURE OUTLOOK

Market Predictions

IDC sees virtualization as having a broad and deep impact on enterprise computing, but the impact will go well beyond today's scenario of server consolidation. We see the long-term impact of virtualization as touching all of the areas that follow:

- **Virtualization will become pervasive and integral to server and operating system design.** In four to five years, we expect that virtualization will be as tightly integrated with the base operating systems as directory services and clustering technology are integrated today. Once fully integrated with the operating systems used aboard high-volume x86 servers and seen as a system "service" that can be used, or not, depending on the deployment scenario of a given system.

- **There will continue to be revenue associated with virtualization layers.** However, that revenue may be disguised as upscale SKUs of Windows and Linux operating systems. We see the distinct potential for products with integrated virtualization to be priced higher, and those upscale products are likely

to include allowances for supporting multiple guest images of the "host" operating system at a reduced or no incremental cost. Microsoft is already doing this with Windows Server 2003, Enterprise Edition (licensed for up to four guest instances) and recently unveiled conceptually similar but expanded use rights with Datacenter Edition (unlimited guests). In Microsoft's case, the business license agreement typically provides "downgrade rights" — which enable customers to deploy any back-version product under the activation key with the new operating system that was just deployed. Novell is supporting unlimited virtualization with SLES 10 (with integrated Xen hypervisor technology). As of the publication of this document, Red Hat has yet to disclose its plans for use of guest instances aboard Red Hat Enterprise Linux 5.

- **Virtualization will change the way offline systems are managed.** The virtualization layer "decouples" the operating system from the underlying hardware, making it possible to manage and provision systems offline, and in a powered-off environment. This capability is enormously empowering and makes it possible for operating systems and layered software to move around from server to server, and for the operating systems to be patched or updated while offline in image form. (The patching and application provisioning concept can be applied to both client and server guest operating systems.)

- **Operating system mobility enables servers outside traditional IT boundaries can be leveraged when needed.** Using virtualization software and the inherent decoupling that takes place between the operating system layer and the hardware, it becomes easy to reallocate resources. When one server runs out of capacity, an operating system and its workloads can be dynamically moved to another machine having unused capacity. In the future, this capability will enable customers to potentially ship that whole software stack on out to a server located out the corporate firewall. Once organizations resolve what is likely to be a myriad of concerns over privacy, confidentiality and security, it becomes entirely possible for a service provider, maybe even Amazon, Google, Microsoft, Sun, or IBM, to provide overflow capacity in an on-demand basis.

- **Traditional IT vendors need to move into this hosting business.** A corollary to the decoupling of the operating system layer from the hardware is that if the operating system vendors don't get directly into the business of offering resources for hosting guest operating system images as part of their core service offerings, or working closely with a large partner to provide this service on its behalf and under their flag, they are leaving a huge market opportunity to competitors, including the online companies mentioned earlier.

- **Thanks to virtualization, mobile employees will be able to leave behind their hardware and take only software with them.** An example of this might be carrying a USB drive containing an operating system image and applications, rather than a whole laptop, when going on a business trip. Taking this concept one step further, given the necessary bandwidth, users could do the same thing without carrying the memory stick, and just download a software image from a browser on a borrowed machine found in the seat back of the airplane, in the hotel room, and so on.

- **Virtualization technology will allow software appliances to exist and be consumed by end users, including consumers, SMBs, and especially enterprises.** These software appliances could be used to isolate a single service or application, or suite of applications from other critical applications. It could also be used to ease manageability of networking and security applications. The ability to isolate and to create and dispose of applications on an on-demand basis could also increase security. This capability is particularly applicable to public-facing applications used at kiosks and in other public environments. Also, this technology is highly applicable for insulating business systems from nonbusiness applications that end users wish to carry aboard their portable work systems.

- **Business models surrounding pricing and licensing will continue to be affected.** Virtualization enables the creation of pure software appliances, which are turnkey packages of operating system software and application functionality, preconfigured in a ready-to-run package. Operating system vendors need to seize this opportunity before it goes to nonpaid competitors. Virtualization also creates the opportunity for ISVs to expand their portfolio to offer fully turnkey software stacks. In this scenario, an ISV can deliver a fully compliance-tested image that includes the operating system, ready for deployment aboard the virtual machine. Customers would only need to load the bits and turn it on. This scenario is closely related to the software appliance opportunity.

- **Virtual-hosted clients will become a viable solution for more organizations.** Virtually hosted clients — where multiple client images can be supported aboard a single server system — become a viable solution for more organizations as virtualization is better understood and more broadly accepted. This scenario leverages not only virtual machine software but also virtual user interface software.

- **Factory preinstalls of server operating systems will decline.** The model widely used today of a preconfigured server, with an operating system preinstalled by the OEM, is likely to shift over time as the base operating system increasingly becomes the hypervisor and customers ask for an otherwise naked machine.

- **Virtualization capabilities will heavily influence the paid-versus-free operating system deployment scenario.** If customers can obtain a current, fully patched, secure operating system for free, deploy it, and then discard it and replace it when security or other factors mandate it (hours, days, or weeks later), the potential for using more free operating systems grows substantially. This trend could negatively impact the potential for operating system revenue growth moving forward. IDC believes that operating systems supporting heavy or complex application workloads are not candidates for such rapid replacement scenarios, but basic infrastructure servers will be ideal for such a round-robin approach of system provisioning and life-cycle management.

ESSENTIAL GUIDANCE

Actions to Consider

Operating system vendors that build their business model around sold/supported licenses and/or subscriptions need to recognize the transitions and potentially strong disruption that virtualization can introduce. Failure to recognize these potential changes — and failure to exploit the new opportunities, including software appliances, rapid-replace operating systems, and remote hosting for customers — will put vendors at risk of being disrupted by competitors.

Vendors that recognize the potential impact — and opportunity — these technologies offer will respond with a broader range of products, which need to range in cost from free, to low cost (under $100/year), to moderately priced, and on up to the enterprise-grade product pricing that exists today. Vendors that cling to the high-end-priced products without competing directly at the low end of the market are placing their existing business at significant risk.

Drawing a parallel with the willingness of traditional steel mills to give up low-profit products, such as the steel reinforcing rod, to upstart competitive minimills as described in Clayton Christensen's *The Innovator's Dilemma,* these operating systems vendors are potentially giving up the software analog to the steel reinforcing rod market (low-end, low-cost operating systems) to the cheap minimills (open source operating systems and software appliance vendors) on the premise there is no money to be made there, and it is not threatening to their profitable core business. Nothing could be further from the scenario we face today.

LEARN MORE

Related Research

- *Microsoft Ups the Anti-Piracy Ante with SPP* (IDC #IcUS20390806, October 2006)
- *New IBM Middleware Price Plan Paves the Way for Virtualization and Subcapacity Pricing* (IDC #203665, September 2006)
- *Worldwide Virtual Machine Software 2006–2010 Forecast* (IDC #203213, September 2006)
- *Worldwide Virtual Machine Software 2005 Vendor Shares* (IDC #203207, September 2006)
- *Breaking the Ice in the Software Appliance Market: Ingres Launches a Database Appliance* (IDC #IcUS20319706, August 2006)
- *Microsoft Confirms Plans for Unlimited Virtualization in Datacenter Server* (IDC #202558, July 2006)

- *VMware Extends Its Virtual Testing Reach with Akimbi Acquisition* (IDC #202410, July 2006)
- *Microsoft Partners With XenSource to Offer Advanced Server Virtualization Software* (IDC #GE03N, July 2006)
- *HP Rolls Out New Blade Chassis with Virtualization, Management, and Network Partners in Mind* (IDC #202184, June 2006)
- *VMware: Virtualization 3.0* (IDC #202061, June 2006)
- *Lowering the Barrier to Entry: VMware Offers Server Virtual Machine Product for Free* (IDC #34885, February 2006)
- *The Role of Server Blades in the Centralization and Consolidation of PCs* (IDC #34129, October 2005)

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