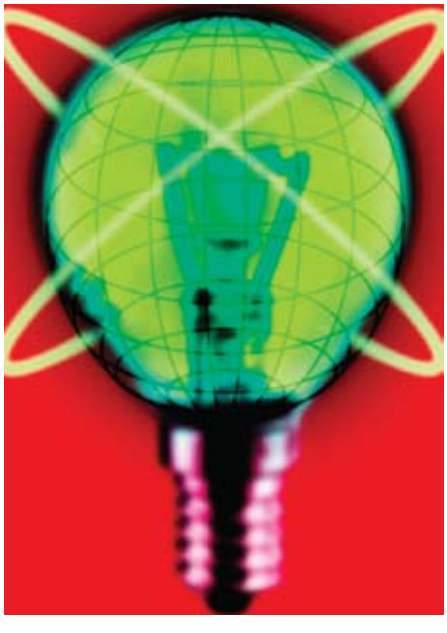
BEST PRACTICES

REAL-WORLD EXPERIENCES OFFER INSIGHTS

Virtualization has become so widespread that clear best practices have emerged.

Propelled by the technologies that VMware and Intel have pioneered, virtualization has rapidly gained market acceptance. Indeed, VMware virtual infrastructure software has some 4 million users and more than 20,000 corporate customers, many of which have been built on Intel-based systems.

One of those corporate customers is Solvay Pharmaceuticals, a chemical and pharmaceutical group with 29,000 employees in 50 countries, which identified virtualization as the solution to contain server growth. "Because we're in a regulated industry, we would need to get three new servers every time we needed a new application—one for development, one for test and one for production," explains Bruce McMillan, Solvay's manager, emerging technologies.



The company implemented VMware® Infrastructure 3 featuring VMware® ESX server hosts on HP ProLiant servers powered by quad-core Intel® Xeon® processors. By going from 65 physical servers to just 17, McMillan says the virtualization implementation "has saved us $1.5 million in pure hardware costs. That's not even counting power and cooling costs, or staffing costs."

There are many more examples of successful virtualization deployments across many industries and mixes of applications, leading to the emergence of clear best practices that can benefit organizations implementing virtualization for the first time.

The Basics

Let's start by reviewing some of the hardware and software elements of virtualization. There are several virtualization architectures or approaches. For example, a hosted virtualization architecture runs the virtualization layer as an application on top of an operating system. VMware® Server for Windows or Linux is an example of a hosted architecture. The virtualization layer in a hosted architecture is at times referred to as a monitor.

In contrast, a hypervisor (also called bare-metal) architecture installs the virtualization layer directly on a system without relying on the OS beneath it. With direct access to the hardware resources, a hypervisor can be more efficient than a hosted architecture and offers better scalability and performance. VMware

ESX server is an example of a hypervisor architecture.

VMware implements both hosted and hypervisor architectures by using the built-in features of Intel® processors and binary translation. The monitor or hypervisor provides full virtualization; the guest OS is decoupled from the underlying hardware, yet fully leverages the capabilities built into the Intel processor, runs at native speed, offers the best isolation and security, and simplifies migration and portability because the same guest OS can run virtualized or on native hardware.

A key advantage of either the hosted or hypervisor approach is that no modifications need to be made to the operating system for it to work in a virtualized environment. The monitor or hypervisor handles all elements of virtualization.

A third approach, paravirtualization, relies on modifying the OS kernel to make certain procedures in the OS aware that the OS is running in a virtualized environment, and replacing those instructions with hypercalls directly to the virtualization layer. For paravirtualization one needs to utilize a specially modified operating system.

Intel has embraced virtualization and offers several new Intel® Virtualization Technology (Intel® VT) features in its processor and chipset silicon to support these virtualization models and accelerate them. The VMware ESX server takes advantage of the features that provide virtualization capabilities in silicon.

In addition to virtualizing the processor instructions, the virtualization layer must virtualize memory and I/O. Memory virtualization involves sharing the physical system memory and dynamically allocating it among virtual machines (VMs) in a manner similar to that used by many operating systems to allocate memory to various applications. To run multiple VMs on one system, the processor's memory management unit must be virtualized to support the various guest operating systems, each of which continues to control the mapping of virtual addresses to the guest memory physical addresses.

Finally, there is device and I/O virtualization, which oversees the routing of I/O requests between virtual devices and the shared physical hardware. For example, virtual network interface cards (NICs) and switches create virtual networks between VMs hosted on the same physical system without the virtual network traffic consuming bandwidth on the physical network. Multiple physical NICs can appear as one and failover is transparent for VMs. VMware® VMotion™ can allow VMs to be seamlessly relocated to different systems while keeping their MAC addresses.

The key to effective I/O virtualization is to preserve these virtualization benefits while keeping the added CPU overhead to a minimum.

Doing Virtualization Right

Welch's, the Massachusetts company perhaps best known for its grape juices, jams and jellies, was dealing with an overgrowth in its data center. "We rely on a substantial amount of technology to keep our production facilities rolling 24/7," says George Scangas, manager of IT architecture, Welch's. "That adds up to a lot of servers within our data center. Over the years, as the number of servers grew, we started to reach our power and cooling limits. We needed to find a better way to manage that growth or else we'd have to forklift our entire data center to a larger facility."

Having been a long-term Intel customer, Scangas said it was a "no-brainer to use Intel as the platform of choice for our virtualization efforts." Welch's implemented VMware Infrastructure 3, featuring the ESX server running on Dell 6600 and 6650s with Intel quad-core processors, as well

as VMware VMotion, VMware® Distributed Resource Scheduler (DRS) and VMware® High Availability (HA).

"So far, the performance within our virtual environment has been outstanding," Scangas says, "and very reliable too. We're able to run as many as 15 virtual machines on one of our ESX hosts. That kind of consolidation has helped us avoid having to move our data center, which would've been a costly and time-consuming endeavor."

In addition to a reduction in server sprawl, Welch's has achieved up to 60 percent CPU utilization on the ESX hosts. Scangas estimates that over a five-year period the company will save $300,000 in hardware costs alone.

When implementing virtualization, companies must often address the question of which hardware platform to choose. The scale-out approach emphasizes the use of more and smaller servers, typically with two sockets, while the scale-up approach emphasizes using fewer, larger servers. Although it's not a requirement that all servers be compatible, to move a VM from one compatible pool of servers to another can mean between 30 seconds and five minutes of downtime. However, with VMware VMotion, there's no downtime to move VMs within compatible pools of servers.

Overall, VMware and Intel have found that quad-core servers are preferable to similar servers based on dual-core processors, typically yielding about 60 percent more performance and about 24 percent better performance per watt, which yields a 30 percent lower TCO. Likewise, in terms of form factor, rack-mounted systems generally provide greater configuration flexibility compared to blade-mounted systems for virtualization. Specifically, the memory configuration, in terms of the number of slots available, tends to be higher for rack-mounted systems compared to blades.

The Dynamic Data Center

The dynamic data center (DDC) is the fulfillment of many long-term IT goals, providing performance, flexibility and capacity at a much lower cost. Applying virtualization successfully to deliver the DDC concept takes preparation. One of the best places to start is with a maturity assessment, which can provide the facts needed to understand an organization's applications, business requirements and operational models so that virtualization can be applied with maximum success.

The DDC will provide the ability to deploy distributed applications and provision the associated virtual machine. More significantly, the DDC enables the automatic and dynamic allocation of resources depending on workloads and business requirements. This capability yields the maximum benefit from IT investments, in terms of utilization, adaptability and alignment with business opportunities.

Two Versus Four

Intel IT compared the performance of two- and four-processor socket servers with Intel quad-core processors in a virtualized environment. The key findings from the study include:

- For memory capacity-limited scenarios, a deployment strategy utilizing the four-socket server supported about 15 percent more VMs for the same TCO when compared with a deployment strategy utilizing two-socket servers.
- The four-socket server offered about twice the scalability in terms of compute performance.
- Deployment strategies based on servers from either of the two categories resulted in comparable TCO per VM when the focus was on meeting performance-focused service level agreements, such as

response time and application throughput.

• Deployment strategies emphasizing two-socket servers had the lowest TCO per VM when server demand was relatively low, which can occur as a result of business policy requirements, limitations imposed by the technology infrastructure and/or limited demand for compute resources at small sites.

Overall, Intel IT's performance comparison found that four-socket systems offer better performance per watt and better TCO. Organizations must look at the computing load to be virtualized in order to determine whether to proceed with scale-up with four-socket systems, scale-out with two-socket systems, or a combination of the two. (To read the white paper, "Comparing Two- and Four-Socket Platforms for Server Virtualization," visit *http://communities.intel.com/docs/DOC-1512*.)

Other Considerations

• When implementing virtualization, avoid putting all high-CPU demand virtual servers on the same physical server. By implementing VMware DRS, computing capacity is dynamically allocated and balanced across hardware resources aggregated into logical resource pools.

• If you are planning a virtualization implementation with existing servers and are running out of power, connectivity or cooling, consider a hardware refresh.

• Deploying newer, higher-performance servers that can host more virtual machines leverages existing virtualization software licenses.

• Consider depreciation. Normally, in a traditional physical server deployment, the payback is three to five years. However, with virtualization, savings on power and management indicators can result in payback in less than one year.

• Consider industry- and application-specific issues. For instance, for applications that don't adapt well to multiple threads, some organizations partition their servers into a number of VMs, each with the appropriate number of CPUs to match the number of threads supported in the application.

• Adequately train staff. Virtualization can be simple, but not all implementations are easy. Therefore, it is important that staff understand all of the issues associated with virtualization and allow sufficient time to bring up new VMs.

• Implement a cross-functional team to oversee virtualization. Just as in a purely physical environment, undisciplined virtualization can lead to sprawl as more VMs are added. This should be a process that has structure and discipline to ensure long-term performance and manageability.

• Avoid becoming "network-bound," which occurs when activities such as VM backup become constrained by limited network capacity. Again, this is an issue that can be anticipated with proper planning.

• In a virtualization implementation, I/O is typically the most substantial expense. In other words, a high level of I/O requirements will have a greater cost impact.

Although the concepts presented here do not cover every possible situation, they can serve as a guide for starting the process of virtualization planning.

VMware and Intel offer combined expertise to ensure infrastructure resources are designed, manufactured and optimized to handle evolving data center requirements. They are continually collaborating to introduce innovative hardware and software enhancements to provide customers with improved security, reliability and manageability. Their close partnership allows users to enjoy near-native performance of applications running in virtualized environments.

For more information about VMware, Intel and their virtualization solutions, go to www.vmware.com/go/intel.