

THE COMPUTERWORLD HONORS PROGRAM

CASE STUDY



LOCATION:
*Palo Alto, California,
United States*

YEAR:
2006

STATUS:
Laureate

CATEGORY:
Business and Related Services

NOMINATING COMPANY:
Morgan Stanley

ORGANIZATION:

VMware

PROJECT NAME:

Virtualization of the Computing Platform

Summary

VMware was founded in early 1998 with the plan to bring a modernized version of virtualization to industry standard compute systems. The vision was that this would greatly improve people's ability to fully utilize, secure, and flexibly manage their compute infrastructure. This vision has resulted in the emergence of a significant industry and also great benefits for VMware's customers. A sampling of those that have standardized on VMware Virtual Infrastructure shows estimated average savings of ~\$1M in hardware, ~\$200K in power, and ~222 hours/month in labor. The customers are seeing a return on investment in anywhere from days to at most 9 months.

VMware started the x86 virtualization market and today has over 20,000 enterprise customers, over four million users, and is partnered with every major industry player in the x86 space. VMware has received over 65 awards for product innovation and excellence and is consistently recognized as the industry leader in virtualization. Network World wrote in December 2005: "while many companies are having a transformative effect on the computer market, one vendor is at the very forefront of acquiring power: VMware. VMware's virtual machine products are some of the best in the market and its financial performance has been stunning." From CNET on March 31, 2006: "it's VMware, which leads the virtualization market." The market-research company IDC estimates that spending around server virtualization will increase to nearly \$15 billion worldwide by 2009.

Introductory Overview

The idea for VMware's virtualization technology and products came out of the notion that compute systems could take a leap forward with a layer of virtualization, that it was possible to offer much better resource, fault, and security isolation, and significantly more flexibility. There was also the notion that new software and hardware should not break existing and working software. Finally, in 1998, processors, memory, disks, and networks had become fast enough and cheap enough that inserting a level of indirection into modern day computer systems would not kill performance.



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The VMware virtualization technology is based on a software abstraction layer that partitions a single hardware platform into one or more virtual machines. The virtual machine is sufficiently 1 to the underlying physical machine to run any x86 operating system and application unmodified. The virtual machine also has the property that it can be moved from one hardware platform to another and will run anywhere the virtualization layer exists.

Benefits

From day one, VMware planned to deliver a full virtualization platform across the range of IA32 based systems. In 1999, VMware shipped its first desktop product. Its benefit was in running multiple different operating systems on the same machine for supporting legacy application compatibly, and for developing and testing multiple different software configurations. VMware Workstation has unprecedented capabilities such as the ability to snapshot running machines, replay sequences of execution, and clone whole networked systems.

VMware's first server product, ESX Server, came out in 2001. VMware's first management product, Virtual Center, shipped in 2003. ESX Server and Virtual Center together form VMware Virtual Infrastructure. VMware ESX Server uses the same core virtualization from the desktop product and put it into a "bare metal" architecture optimized for performance, scalability, and sophisticated dynamic hardware resource management. VMware Virtual Center broadened the capabilities of VMware ESX Server by introducing monitoring, provisioning, and management capabilities for the virtual machines. Virtual center also included the groundbreaking VMotion technology which enables live migration of running virtual machines across physical hardware with zero-downtime.

The initial driving application for VMware Virtual Infrastructure was server consolidation. Non-virtualized x86 servers typically run at 5-15 percent capacity. This is because every time there is a new application to deploy, a new server is purchased and most applications do not come close to using all of a machine. Virtualization makes it possible to partition a single server into multiple fully isolated virtual servers thus making it possible to drive utilization up into the 80-85 percent plus range. People can reduce the number of servers they need to run by four to as much as 30-to-1.

Other areas where users are now deriving great benefit from Virtual Infrastructure include provisioning, disaster recovery, and zero downtime serviceability. Each is described below. Stronger security and dynamic load balancing are also functions that virtualization facilitates.

Provisioning a machine traditionally requires ordering new hardware, installing it, installing the operating system, and then finally the application. With virtual infrastructure, the operating system and application can be pre-installed in a virtual machine and managed like a file. Provisioning is then as simple as finding spare cycles on an already deployed machine, cloning the virtual machine to it, giving it an ID on the network and then just running it. On average, customers say that provisioning times go from days and weeks down to a few hours when deploying virtual machines instead of physical machines.

Traditional disaster recovery requires that two identical machines be configured and maintained in lockstep at a primary and a geographically-remote failover site. With virtual infrastructure, the dependence on the hardware is removed so that the two machines no longer need to be identical and maintained in lockstep. The virtual machine just needs to be available at both sites and



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rapid disaster recovery is possible. Disaster recovery is the number two driving application for people adopting virtual infrastructure due to the greatly reduced logistics and potential pitfalls.

Zero downtime serviceability is something new that Virtual Infrastructure makes possible. This is through a VMware invented technology called VMotion. If a machine needs servicing such as a memory upgrade, it can be done in the middle of the day without needing to schedule downtime. VMotion allows a workload to be moved from one machine to another without service interruption. The machine to be serviced can be offloaded, taken down and serviced, and when it is back online, the workload can be “VMotioned” back. During the servicing time, the end-users see no interruption in their service.

The Importance of Technology

The benefits described above have resulted in huge savings for businesses. They have also allowed IT people and developers to run their operations with significantly more productivity, reliability, and agility while eliminating much of the drudgery from their jobs.

Below are some representative VMware Virtual Infrastructure end-user quotes:

- “We have completely transformed our IT infrastructure by moving to a virtual infrastructure and the benefits are being felt already. Our hardware, resources are being used more efficiently, enabling us to start bringing power and space consumption under control.” — Stephen Powell, Enterprise Solutions Lead - Project & Design Office, Atkins
- “Once we introduced VMware ESX Server, it caught on faster than I could have imagined. Even more amazing than the product’s efficiency was the way it reduced our costs.” — Paul Poppleton, IT Manager, QUALCOMM
- “Using VMware virtual infrastructure, we can offer the same levels of service and more flexibility for up to 40 percent lower server and operating system costs” --Rob Jones, Director of Technology, Northern Europe ALSTOM
- “It used to be install, install, install, test, test, test. Now we do more testing and developing -- and less installing.” Robert Kennedy, Principal Software Engineer, NetIQ

In terms of how VMware helps the global community, we give away product to various groups including for educational institutions, nonprofits, and open source projects. We also give away a basic version of our product to everyone so that more people can experience virtualization, and encourage the building and sharing of virtual machines. This is proving to help the software industry as people can more readily share, evaluate, and develop third party software. Oracle has distributed over 100,000 virtual machines with their latest database software ready to run. VMware has distributed over 200,000 copies of an Ubuntu Linux, Firefox browser appliance to consumers; it allows people to browse and use the Internet without risk of contaminating their computer with viruses or spyware. We have seen millions of downloads of our free products.

We see that virtualization is helping to make some of the world more efficient and effective; people are saving time, saving power, and saving on the need for more compute infrastructure. Virtual machines are also making software more accessible to non-technical users as it allows it to be packaged as an appliance.



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Originality

VMware took an old computer concept, virtualization, and both modernized and added major new invention to it. VMware also created, on the business side, a new category of software and industry. VMware has done this all in 8 years.

Virtualization was not trivial to bring to the x86 market. It was originally deployed by IBM on expensive mainframes in the late 60's. By the late 1980s, the virtualization was viewed as little more than a historical curiosity. When the Intel IA32 architecture was designed in 1985, no support for virtualization was added. It was believed that modern operating systems had supplanted the need for virtualization since computers had come down in cost so much.

The first product we launched was to the Linux desktop market as a way to run Windows operating system on top of a Linux desktop operating system. We took the novel step of making the fully functional product available for download with a free 30 day trial license. This worked extremely well, our beta had 75,000 participants which allowed us to bulletproof the software and also start to establish credibility. It was also fun. Below are some of the early emails from the first VMware customers:

Date: Tuesday, April 05, 1999 10:31 AM
Subject: vmware for Linux Beta

Congratulations for that amazing product. I can't believe what I see. I think it's the best discovery after landing on the moon. The only thing I can't believe is why is it beta? Other software isn't that stable in an end-version...

Greetings olaf doering

Date: Sunday, April 25, 1999 4:59 AM
Subject: VMware

I am just plain baffled by VMware. Wow! I've seen a lot buy Your app just kicks butt.Thanks a *lot* to you and all people at VMware for providing this killer!

In deep admiration ;-)

Tom

Date: Friday April 16, 1999 12:23 PM
Subject: from a beta user...

This is the coolest software I've ever seen. You folks must have brains the size of volkswagons.
David Laufnick

Another problem we had was that we were setting out to define a new category of software. VMware had modernized the original concept of the 'virtual machine' from the IBM Mainframe and adapted it to commodity hardware platforms and it was more curiosity than anything. What first appeared to be a routine positioning exercise turned out to be quite challenging, much of our target audience just did not get the value proposition. We discovered that our positioning lacked context – a definition of the product and market space differentiated from



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other competitive categories.

In actuality, our positioning has changed very little from the beginning but now it is well understood in the industry where VMware remains the leader. We have also gone on to define a broader category, virtual infrastructure, which includes the use of the virtualization platform to secure and manage computer systems and their data in a way that is better than what is possible without a virtualization layer.

We were finally able to enter the enterprise server market first in partnership with IBM. Shortly thereafter came HP and then followed by Dell. Even though IBM had significant appreciation of the benefits of virtualization, we still had our challenges. An early email from a senior technical person at IBM read: "Between you and me, I think we have some influential people on this team who can help get this moving in spite of the Marketing view."

It did get moving and VMware virtual infrastructure now has a little over 10% of the x86 based workloads. We believe that in a few years, all x86 workloads will be deployed on a virtualization layer as it does facilitate a better way to compute.

Success

The IA32 architecture that VMware had to work with in 1998 did not have virtualization support, first major technical challenge to make our technology run with acceptable performance. When VMware first called Intel to meet and show them what we had done, they thought it was not possible. (Now, in 2006, Intel has amended the IA32 chip set design to include virtualization support.)

After the development of the performant core virtualization, the next major technical hurdle was to fully model all the aspects of modern compute systems. This meant adding symmetric multiprocessing support. VMware virtual infrastructure has just added 4-way SMP. No one else has been able to replicate this capability to date with even 2-way SMP which VMware introduced in 2003.

Another significant invention from VMware and key to the Virtual Infrastructure is "VMotion", a way to take a running workload and with no service interruption, move it across physical machine boundaries. VMotion has proved to be a major breakthrough for day to day IT operations. It lets them do routine maintenance in the middle of a workday rather than waiting until the wee hours of their weekends.

In addition to the technical hurdles and inventions, the business side also required some innovation or at least perseverance. When we started out in 1998 our plans to virtualize commodity systems did not exactly impress. The venture capitalists generally thought we were in need of "the killer application". Some suggested we should be a service provider, others thought we should build hardware and advantage it with our software, still others thought we had to build a specific application like high availability. Most were very skeptical that we would ever make it in the enterprise server market. We stuck to building a horizontal platform that we introduced on the desktop first.

Building the virtual infrastructure products, bringing them to market, and seeing the excitement and appreciation of our end-users and partners in this newly forming industry has been a wonderful experience.



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Difficulty

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