

Best Practice recommendations for the use of Hardware and Operating System Virtualization in the creation of new Virtualization Solutions

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Document Overview

Many organizations today are interested in deploying a machine virtualization solution and are looking for a primer on the basic technology options that are available and their relative benefits and limitations. The most common approach today is Hardware Virtualization and is best represented in the commercial product VMware ESX Server. Somewhat less widely known, but critical to a complete understanding, is Operating System Virtualization which is best represented by the Parallels Virtuozzo Containers product.

The purpose of this document is to accurately describe the differences and practical applications of Hardware Virtualization and Operating System virtualization and to describe the ideal applications for both technologies in typical enterprise environments. Larger organizations are likely to benefit from both technologies so it is essential to fully understand both approaches before beginning the design and implementation phases of new projects.

An overview of both technologies is presented highlighting both the benefits and downsides of each approach. In addition, specific recommendations based on our recent customer experiences are included in table form to provide concrete and relevant examples of target applications of each technology. These will also be contrasted to cases where virtualization is not the best option and a true “hardware” server is preferred.

1.0 Definitions of types of Machine Virtualization

Traditionally, a computer system is comprised of dedicated hardware components (CPU, Memory, storage, I/O, etc.), the operating system, and, the software applications that run within this combined hardware/software environment. Virtualization is the broad term which describes the ability to create and run compute environments without the need for separate and distinct resources at each of these layers. This means that a computer instance can be created which shares some aspects of these resources without the need for separate hardware devices, operating systems or software applications. The most common example is the ability to run multiple computers, i.e. fully functional “machines”, each with their own identity on the same hardware and operating system host device.

While this functionality has been available for many years on a range of computer platforms the scope of this paper is focused on the utilization of technologies that are based on the most common Intel x86, Windows and LINUX found in typical corporate compute environments. We will focus on two selected product technologies and define their ideal applications for such environments.

1.0.1 Hardware Virtualization or “Hypervisor” Technology

This approach is the most commonly encountered today and is most well represented in the form of **VMware ESX by VMware, Inc.** It is best understood to represent an operating software layer that allows multiple hosts to run concurrently on the same hardware. Each host is a complete virtual machine with the hardware it requires provided to it in a software emulation layer. From the point of view of each running virtual host, it has it’s own CPU, Memory, I/O, etc. available to it’s operating system instance. As a result the complete server image in hard disk, operating system, memory and devices is loaded and running on the host computer. No elements of the operating system are shared, each machine exists an isolated environment in which all hardware devices are emulated in software. The operating system software is unchanged from the traditional approach of a dedicated hardware machine except now multiple machines can share the same underlying hardware resources. This inherently allows for any compatible x86 operating system to run as a virtual machine.

1.0.2 Operating System Virtualization

This approach is best represented in the form of **Parallels Virtuozzo Containers**. Unlike Hardware virtualization, this approach leverages the host operating system to provide core functions to each virtual machine. Rather than emulate hardware and present a traditional hardware device to the guest virtual machine, each virtual machine can share the host hardware resources, operating system components and virtualized software applications. The end result is a fully functional standalone virtual machine that does not require the duplication of a hard disk image, OS footprint/RAM image, or, separately installed applications. This inherently requires that the guest operating system be based on the same operating system as the host but offers much greater efficiency of resources.

1.1 Similarities and Differences in Hardware versus Operating System Virtualization

These approaches can be considered to have many common elements and share many of the same benefits. Some key similarities are:

- ✓ Ability to consolidate servers on to less physical hardware devices with potentially significant savings in space, power, cooling and overall hardware management
- ✓ Intelligent allocation of resources (ability to assign hardware resources as required by applications, not by physical hardware systems)
- ✓ Minimize Downtime and provide superior Business Continuity
- ✓ Provide easy access to test/development environments, i.e. exercise planned projects and solutions in simulated environments before committing physical resources
- ✓ Provide enterprise desktop environments through virtual machines rather than traditional desktop device management approaches
- ✓ Support for clustering Hardware hosts to allow auto-failover over in the event of a host hardware failure

Some Key Differences are:

- ❖ *VMware virtualization* supports most x86 compatible guest operating systems, can “inherit” legacy servers such as NT4 and Windows 2000 removing the need to run them on physical hardware which may be end of life, or, not cost prohibitive to replace and maintain
- *Virtuozzo virtualization* spawns guest machines with the same operating system as host (Windows 2003 32-bit, 64 bit and LINUX), is not compatible with older operating system versions such as NT4. Support of these other systems may be required when consolidating legacy systems that are still in production use.

- ❖ *Virtuozzo* re-uses large portions of the host resources and therefore requires significantly less server infrastructure to support the same target computer load
- *VMware* requires the same disk and memory resources as the original physical server it emulates, while providing consolidation benefits does little to reduce overall resource requirements. For specific performance metrics on hypervisor versus operating system virtualization see the recent white paper by HP entitled: [Performance Evaluation of Virtualization Technologies for Server](#)

- ❖ *Virtuozzo* provides services packs and patches to all virtual machines by virtue of patching the host. This fact minimizes the sprawl of OS instances and simplifies patch management overall. Individual patches can selectively be applied to virtual machines on a per virtual machines basis to address selective compatibility issues.
- *VMware* requires that each operating system be treated as a separate entity and patched/updated in the traditional way. Has the benefit of allowing each machine to be completely different, but requires more maintenance.

- ❖ *VMware* allows virtual machines to be migrated to different physical hosts with no interruption of service utilizing the V-Motion feature
- *Virtuozzo* allows LINUX virtual machines to be migrated to different physical hosts no interruption of service but has an interruption of 15-30 seconds for Windows virtual machines

- ❖ *VMware* requires a more expensive and complex SAN infrastructure to take full advantage it’s integrated High Availability (HA) and V-Motion features. These features are currently more advanced in VMware and for some critical applications may be a better option
- *Virtuozzo* does not require specialized SAN storage to enable all features such as virtual machine migration. Being more efficient in CPU, RAM and Disk it requires a much lower cost of support infrastructure overall and will support a similar computer load on a much smaller number of x86 servers and storage space. Microsoft clustering is supported on host and virtual machine instances.

- *Virtuozzo* includes integrated application delivery and live server backup features. These can extend the value of Virtuozzo well beyond simple hardware server consolidation benefits and literally allow the “point and click” creation of servers and a comprehensive backup/recovery strategy with a single product.
- *VVMware* does not provide this functionality directly and instead utilizes standard external methods for server backup and application delivery. It does have the ability to represent the virtual server as a single disk file which is a powerful addition to existing SAN and NAS backup strategies.

- *VMware* provides a dedicated virtual hardware machine and therefore all installed software, including kernel mode drivers, are supported as in a stand alone machine
- *Virtuozzo* shares host resources and while it provides excellent machine and process isolation, it supports kernel mode drivers in virtual machines on a white list basis only with the white list created by Parallels through validation/testing and the request of end users and ISV’s

2. High Level Recommendations

This section provides high level recommendations which can be easily understood to guide the planning stage of when to choose VMware or Virtuozzo as the ideal delivery platform. The common benefits already covered are equally available in both products. This section provides a summary which can be used to quickly point to the correct approach for any given business or technology requirement. Note that an additional heading is given point out where physical servers remain the best option and virtualization is not a best practice:

VMware is best when the following features are required:

- Virtualization is required for multiple/varied operating systems or service pack levels that should remain unique for each virtual machine
- Require ability to migrate Windows machines to alternate hardware host with no interruption of service
- Target applications install/run kernel mode drivers

Virtuozzo is best when the following features are required:

- Standardization of virtual machine operating systems and service pack levels is preferred (Windows 2003 and LINUX)
- The lowest cost for software and infrastructure is required
- Maximum reduction in number of physical servers and managed OS instances
- Application delivery and live server backup should be integrated into the deployment process

Raw hardware running a local Operating system is best when the following features are required*:

- Maximum performance for compute intensive or transactional systems with high I/O requirements
- Certain specialized function machines, especially with proprietary hardware devices attached such as telephone systems, voice mail managers, time clock hardware, etc.

2.1 Specific Recommendations by Server Type

The following table provides some common server roles that are found in our customer environments and whether they should be generally should be executed on dedicated Physical Servers, VMware or Virtuozzo. This varies mainly by volume of transactions and overall computer resources and can also be impacted by specifics of the target applications characteristics. The following are general guidelines only and are intended to convey what practical experience has shown to be most effective, most of the time. Your own choices should be validated through specific application and load testing in the target environment. The ideal platform is the optimal balance of performance, cost and manageability in your environment and will vary by the specific needs and priorities of each environment.

	Ideal Platform		
	<u>Physical Server</u>	<u>VMware</u>	<u>Virtuozzo</u>
Server Role			
High Transaction Volume SQL	X		
Low-Med SQL DB		X	X
High Volume Exchange	X		
Low Volume Exchange		X	X
Active Directory (high object count)	X		
Active Directory (light object count and/or redundant services)	X	X	X
Licensing Servers		X	X
Legacy Server Consolidation (NT, 2000, other x86 OS)		X	
General Purpose LINUX		X	X
High Volume LINUX	X		
Citrix Presentation Application Server Heavily Loaded	X		
Citrix Presentation Application Server Light Load		X	X

Citrix secondary support roles		X	X
Lightly Loaded Specialized Application servers		X	X
Virtual Desktop XP/Vista		X	
Virtual Desktop 2003			X
Web Services Heavy Load	X		X
Web Services Light Load		X	X
Specialized services with hardware specific interfaces	X		