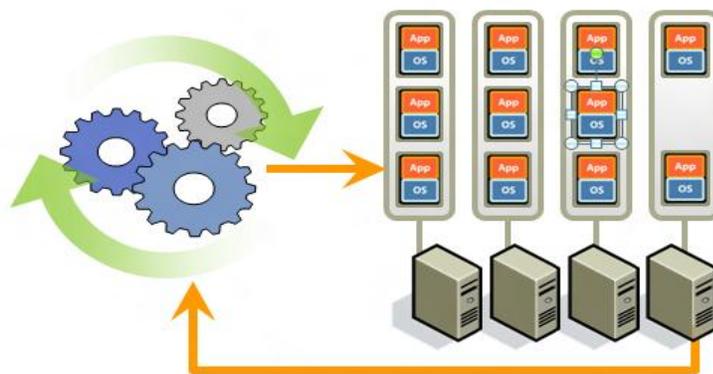


# VIRTUALIZATION

Vikas Garg

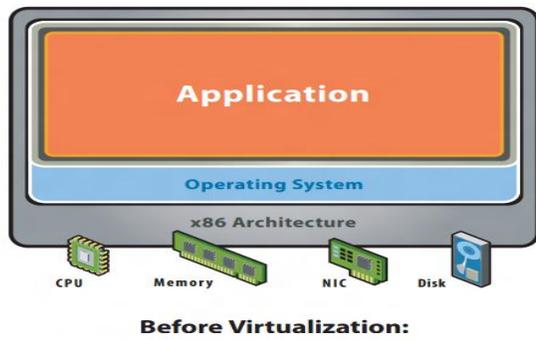
**Abstract:** The main aim of the research was to get the knowledge of present trends and technologies used in it field. Virtualization Allows multiple applications to run in isolation within virtual machines on the same physical machine. Virtualization provides direct access to the hardware resources to give you much greater performance than software emulation. VMware provides hardware virtualization that presents a complete x86 platform to the virtual machine. By doing this project we get an opportunity to learn about an emerging field of IT Sector. They also gave us the details of project like ‘Storage Vmmotion’ on which HP is currently working.

**Introduction:** Among the leading business challenges confronting CIOs and IT managers today are: cost-effective utilization of IT infrastructure; responsiveness in supporting new business initiatives; and flexibility in adapting to organizational changes. Driving an additional sense of urgency is the continued climate of IT budget constraints and more stringent regulatory requirements. Virtualization is a fundamental technological innovation that allows skilled IT managers to deploy creative solutions to such



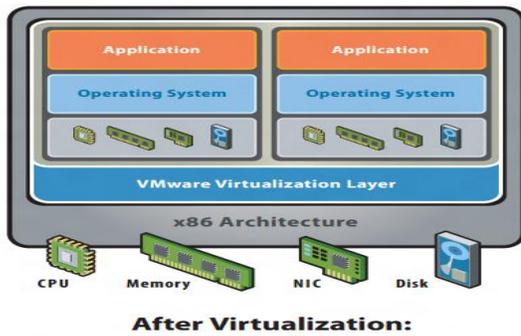
business challenges.

Simply put, virtualization is an idea whose time has come. The term virtualization broadly describes the separation of a resource or request for a service from the underlying physical delivery of that service. With virtual memory, for eg. computer software gains access to more memory than is physically installed, via the background swapping of data to disk storage. Similarly, virtualization techniques can be applied to other IT infrastructure layers - including networks, storage, laptop or server hardware, operating systems and applications. This blend of virtualization technologies or virtual infrastructure provides a layer of abstraction between computing, storage and networking hardware, and the applications running on it (see Figure 1). The deployment of virtual infrastructure is non-disruptive, since the user experiences are largely unchanged. However, virtual infrastructure gives administrators the advantage of managing pooled resources across the enterprise, allowing IT managers to be more responsive to dynamic organizational needs and to better leverage infrastructure investments.



**Before Virtualization:**

- Single OS image per machine
- Software and hardware tightly coupled
- Running multiple applications on same machine often creates conflict
- Underutilized resources
- Inflexible and costly infrastructure



**After Virtualization:**

- H/w-independence of operating system and applications.
- Virtual machines can be provisioned to any system.
- Can manage OS and application as a single unit by encapsulating them.

**Server consolidation and containment:**

Eliminating 'server sprawl' via deployment of systems as virtual machines (VMs) that can run safely and move transparently across shared hardware, and increase server utilization rates from 5-15% to 60-80%.

- Test and Development Optimization:

**Rapidly provisioning test and development servers by reusing pre-configured systems, enhancing developer collaboration and standardizing development environments**

**• Business Continuity**

Reducing the cost and complexity of business continuity (high availability and disaster recovery solutions) by encapsulating entire systems into single files that can be replicated and restored on any target server thus minimizing downtime.

**• Enterprise Desktop**

Securing unmanaged PCs, WS and laptops without compromising end user autonomy by layering a security policy in software around desktop virtual machines.



|                              | BEFORE VMware | AFTER VMware | SAVINGS                      |
|------------------------------|---------------|--------------|------------------------------|
| Servers                      | 1000          | 80           | \$5,816 (per server removed) |
| HBAs                         | 500           | 160          | \$290                        |
| SAN Switches                 | 22            | 8            | na                           |
| Network Switches             | 84            | 10           | \$296                        |
| Power (kWh)                  | 407           | 52           | \$759                        |
| Cooling (kWh)                | 509           | 64           | \$949                        |
| Real Estate (Sq ft)          | 2053          | 257          | \$431 <sup>(3yr)</sup>       |
| Total Savings (Over 3 years) |               |              | \$8,541* (per server)        |

While the Virtualization is the part of IT landscape for decades, it is recently in (1998) the VM Ware delivered the benefits of virtualization to industry-standard x86-based platforms, which now form the majority of desktop, laptop and server shipments. A key benefit of virtualization is the ability to run multiple operating systems on a single physical system and share the underlying hardware resources known as partitioning

Today, virtualization can apply to a range of system layers, including hardware-level virtualization, operating system-level virtualization, and high-level language virtual machines. Hardware-level virtualization was pioneered on IBM mainframes in the 1970s, and then more recently Unix/RISC system vendors

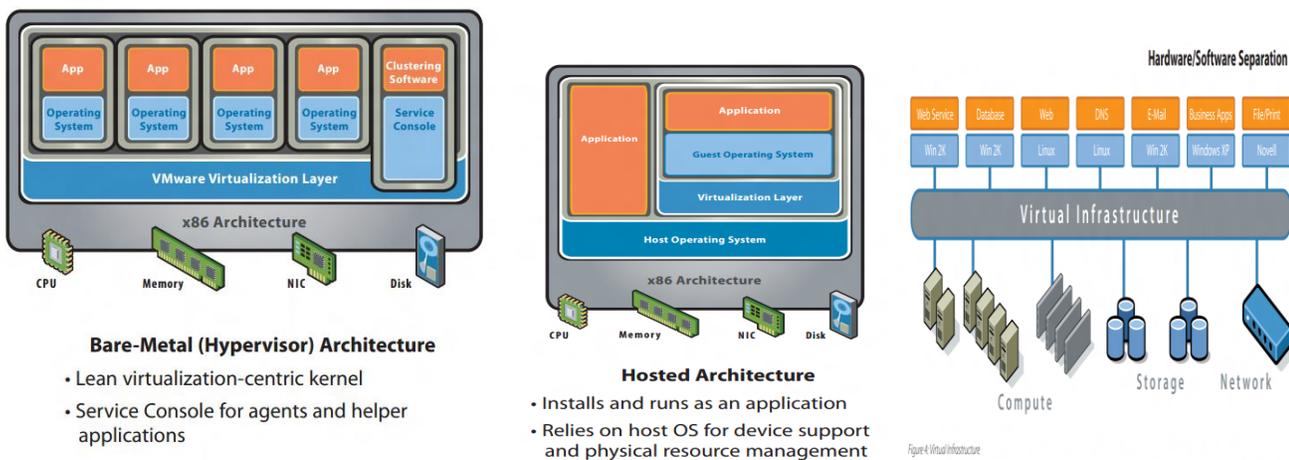
began with hardware-based partitioning capabilities before moving on to software-based partitioning. For Unix/RISC and industry-standard x86 systems, the two approaches typically used with software-based partitioning are

hosted and hypervisor architectures (See Figure 2). A hosted approach provides partitioning services on top of a standard operating system and supports the broadest range of hardware config. In contrast, a

**hypervisor architecture is the first layer of software installed on a clean x86-based system (hence it is often referred to as a “bare metal” approach). Since it has direct access to the hardware resources, a hypervisor is more efficient than hosted architectures, enabling greater scalability, robustness and performance.**

Hypervisors can be designed to be tightly coupled with operating systems or can be agnostic to operating systems. The latter approach provides customers with the capability to implement an OS-neutral management paradigm, thereby providing further rationalization of the data center. Application-level partitioning is another approach, whereby many applications share a single operating system, but this offers less isolation (and higher risk) than hardware or software partitioning, and limited support for legacy applications or heterogeneous environments. However, various partitioning techniques can be combined, albeit with increased complexity. Hence, virtualization is a broad IT initiative, of which partitioning is just one facet. Other benefits include the isolation of virtual machines and the hardware-independence that results from the virtualization process. Virtual machines are highly portable, and can be moved or copied to any industry-standard (x86 based) hardware platform, regardless of the make or model. Thus, virtualization facilitates adaptive IT resource management, and greater responsiveness to changing business conditions (see Figures 3-5).

To provide advantages beyond partitioning, several system resources must be virtualized and managed, including CPUs, main memory, and I/O, in addition to having an inter-partition resource management capability. While partitioning is a useful capability for IT organizations, true virtual infrastructure delivers business value well beyond that. **Figure 3: Traditional Infrastructure**

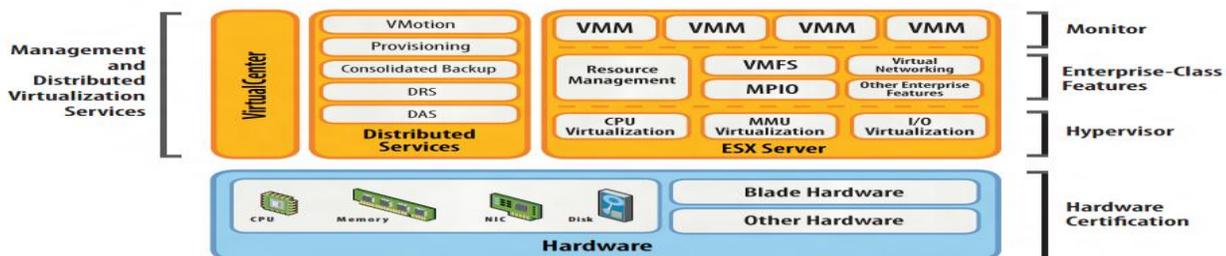


**Virtual infrastructure initiatives often spring from data center server consolidation projects, which focus on reducing existing infrastructure “box count”, retiring older hardware or life-extending legacy applications. Server consolidation benefits result from a reduction in the overall number of systems and**

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related recurring costs (power, cooling, rack space, etc.)

While server consolidation addresses the reduction of existing infrastructure, server containment takes a more strategic view, leading to a goal of infrastructure unification. Server containment uses an incremental approach to workload virtualization, whereby new projects are provisioned with virtual machines rather than physical servers, thus deferring hardware purchases. It is important to note that neither consolidation nor containment should be viewed as standalone exercise. In either case, from ownership (TCO) perspective, with a focus on the ongoing, recurring support and management costs, in addition to one time, up-front costs. Data center environments are becoming more complex and heterogeneous, with correspondingly Monitor Management and Enterprise-Class Distributed Features Virtualization Services Hypervisor Distributed Services ESX Server Hardware Certification Memory CPU NIC Disk Hardware managed. Partitioning alone does not deliver server consolidation or containment, and in turn consolidation does not equate to full virtual infrastructure management. Beyond partitioning and basic component-level resource management, a core set of systems management capabilities are required to effectively implement realistic data center solutions (see Figure 6). These management capabilities should include comprehensive system resource monitoring (of metrics such as CPU activity, disk access, memory utilization and network bandwidth), automated provisioning, high availability and workload migration support.



Extensive ‘scale-out’ and multi-tier application architectures are becoming increasingly common, and the adoption of smaller form-factor transition to blade architectures is generally driven by a desire for physical consolidation of IT resources, virtualization is an ideal complement for blade servers, delivering benefits such as resource optimization, operational efficiency and rapid provisioning. The latest generation of x86-based systems feature processors with 64-bit extensions supporting very large memory capacities. This enhances their ability to host large, memory-intensive applications, as well as allowing many more virtual machines to be hosted by a physical server deployed within a virtual infrastructure. The continual decrease in memory costs will further accelerate this trend. Likewise, the forthcoming dual-core processor technology significantly

benefits IT organizations by dramatically lowering the costs of increased performance. Compared to traditional single-core systems, systems utilizing dual-core processors will be less expensive, since only half the number of sockets will be required for the same number of CPUs. By significantly lowering the cost of multi-processor systems, dual-core technology will accelerate data center consolidation and virtual infrastructure projects. Beyond these enhancements, VMware is also working closely with both Intel and AMD to ensure that new processor technology features are exploited by virtual infrastructure to the fullest extent. In particular, the new virtualization hardware assist stream operating systems enhancements (Intel's "VT" and AMD's "Pacifica") will enable robust virtualization of the CPU functionality. Such hardware virtualization support does not replace virtual infrastructure, but allows it to run more efficiently.

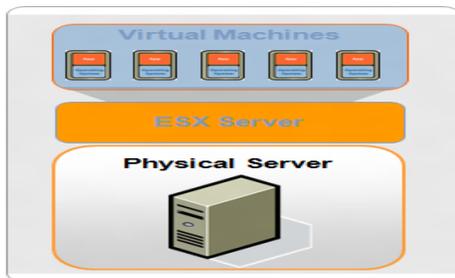
Although virtualization is rapidly becoming mainstream technology, the concept has attracted a huge amount of interest, and enhancements continue to be investigated. One of these is blade servers is growing dramatically. Since the para-virtualization whereby operating system compatibility is traded off against performance for certain CPU-bound applications running on systems without virtualization hardware assist(see Figure 7). The para-virtualized model offers potential performance benefits when a guest operating system or application

is 'aware' that it is running within a virtualized environment, and has been modified to exploit this. One potential downside of this approach is that such modified guests cannot ever be migrated back to run on physical hardware. In addition to requiring modified guest operating systems, para-virtualization leverages a hypervisor for the underlying technology. In the case of Linux distributions, this approach requires extensive changes to an operating system kernel so that it can coexist with the hypervisor. Accordingly, mainstream Linux distributions (such as Red Hat or SUSE) cannot be run in a para-virtualized mode without some level of modification. Likewise, Microsoft has suggested that a future version of the Windows operating system will be developed that can coexist with a new hypervisor offering from Microsoft. Yet para-virtualization is not an entirely new concept. For example, VMware has employed it by making available as an option enhanced device drivers (packaged as VMware Tools) that increase the efficiency of guest operating systems. Furthermore, if and when para-virtualization optimizations are eventually built into commercial enterprise Linux distributions, VMware's hypervisor will support those, as it does all main.

**Figure 7: Para-virtualization**



## ESX Server:



VMware's hypervisor for the data center is called "ESX Server" First launched in 2001, we are now on the third generation at ESX 3, serving over 20,000 enterprise customers. ESX Server is a bare metal virtualization platform, that is, it sits on top of the server hardware directly and allows partitioning of the underlying CPU, memory, network and storage resources between virtual machines that sit on top of it. This hypervisor layer is an important choice to make especially because when you consolidate several servers onto a single one with many virtual machines, the hypervisor layer needs to be sturdy and reliable.

**Performance:** Bare metal hypervisor architecture near native performance. ESX Server allows consolidation ratios of 10:1, 20:1 and sometimes as high as 30:1. Customers report that most people don't even realize they are running virtualized. This is a testament to how solid the performance of the hypervisor is. **Stability:** >3 years of uptime at a customer, 86% of customers use in production, 43% standardize on VMs **Scalability:** The hypervisor needs to scale to meet workload requirements – ESX Server supports 4 way VSMP (running VMs with as many as 4 CPUs assigned to them), 64GB RAM, support for 64-bit Guest operating systems and supports servers with upto 128 GB of physical memory.

**Conclusion:** The key tool for this is Virtual Center. This is your single pane of glass view to your ESX servers and Virtual Machines. It provides the functions for activating VMotion, setting up DRS & HA, and monitoring system performance. It also provides fine-grain access controls allowing you to assign specific roles and privileges to your various administrators and partners. For example, the application team might have privileges to administer VM's or set priorities within a resource pool, but not be allowed to configure ESX servers. But focusing just on the provisioning capabilities, Virtual Center allows you

**manage “templates” or golden images of virtual machines that can be preconfigured with all of your typical security settings and services. When a new “server” is required for an application, you can deploy it instantly from the template. Similarly, you can clone an existing, running VM. This is helpful when you want to test a patch, for example, before applying it to the production copy of the VM. Centralized management capabilities allow to organize, monitor, and configure the entire environment through a single interface resulting in lower operating costs. Rapid provisioning with deployment wizard and virtual machine templates reduces the time and effort for creating and deploying virtual machines to a few mouse clicks. Performance monitoring capabilities, including utilization graphs of CPU, memory, Disk I/O, and Network I/O provide the detail needed to analyze the performance of physical servers, and the virtual machines they are running**

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