Virtualization: an Old Concept in a New Approach

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Virtualization technology is transforming today's IT community, offering new possibilities to improve the performance and efficiency of IT infrastructure by a dynamic mapping of the PC resources, enabling to run multiple applications and operating systems on a single physical system. Virtualization also offers high availability and error recovery solutions by encapsulating entire systems into single files that can be replicated and restored on any destination machine.

This paper brings new elements related to the concept of virtualization, presenting the principles, the new architectures and the advantages of the virtualization. We make also a brief comparison between the PC's functional structure before and after the virtualization. Finally, we present licensed software to create and run multiple virtual machines on a personal computer.

Keywords: Virtualization, hypervisor, partitioning, virtual machine

1 What is Virtualization?

The American company VMware can help us to find the appropriate definition for this concept. So, *Virtualization is an abstraction layer that decouples the physical hardware from the operating system to deliver greater IT resource utilization and flexibility*[1].

The concept isn't new, it was first introduced in the 1960s to allow partitioning of large, mainframe hardware, but in time, PCs provided a more efficient way to distribute processing power, so by the 1990s, researchers began to see how virtualization could solve some of the problems associated with the proliferation of less expensive hardware, escalating management costs and vulnerability.

Virtualization allows multiple virtual machines, with heterogeneous operating systems to running separately, on the same physical machine. Each virtual machine has its own set of virtual hardware (RAM, CPU, NIC, Disk) upon which an operating system and applications are loaded. The operating system sees a consistent, normalized set of hardware regardless of the actual physical hardware components.

Another advantage of virtual machines is that they are encapsulated into files, making it possible to rapidly save, copy and provision a virtual machine. Full systems (fully configured applications, operating systems, BIOS and virtual hardware) can be moved, within seconds, from one physical server to another for zero-downtime maintenance and continuous workload consolidation.

Some of the advantages of Virtualization are:

1.Partitioning hardware and software – meaning multiple applications and operating systems are supported in a single physical system, computing resources treated as a uniform pool to be allocated to virtual machines in a controlled manner

2.The isolation between host machine and virtual machines, the functional independence of virtual machines and their applications, that can only communicate over network connections

3.The possibility to save as a single file of the complete virtual machine environment (named also Encapsulation).

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 example, 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.

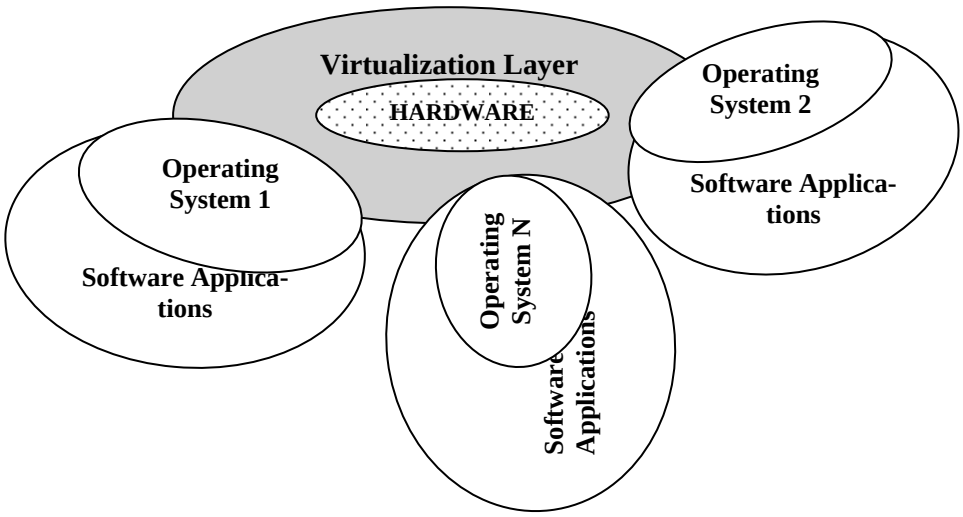

Fig.1. The Virtualization Layer provides a layer of abstraction between hardware and the applications

A brief comparison between the PC's functional structure before and after the virtualization gives us the next information:

- Instead of a single Operating System, the ability to run multiple operating systems on a single physical system and share the underlying hardware resources (*partitioning)*.
- Instead of an unsecured, unmanaged PC, workstation or laptop, the virtualization solves the problems by layering a security policy in software around desktop virtual machines;
- Virtualization offers a hardware independence of Operating Systems and applications;
- Virtualization offers high availability and error recovery solutions by encapsulating entire systems into single files that can be replicated and restored on any destination server.

In 1998, VMware company delivered the benefits of virtualization to industry-standard x86-based platforms, which now form the majority of desktop, laptop and server equipments and it can be applied to a range of system layers, including hardware-level, operating system level, and high-level language [2].

Hardware-level virtualization began on IBM mainframes in the 1970s, and then more recently Unix/RISC systems began with hardware-based partitioning capabilities before moving on to software-based partitioning.

2. Virtualization architectures

For industry-standard x86 and Unix/RISC systems, there are two approaches [1] typically used with software-based partitioning: hosted and hypervisor architectures.

A ***hosted approach*** (Figure 2) provides partitioning services on top of the operating system and supports the broadest range of hardware configurations. The main characteristic of the virtualization is the capability to run as an application, based on host Operating System for device support and physical resource management. There are two kinds of applications on the same machine: dependents on host OS and based on Virtualization Layer.

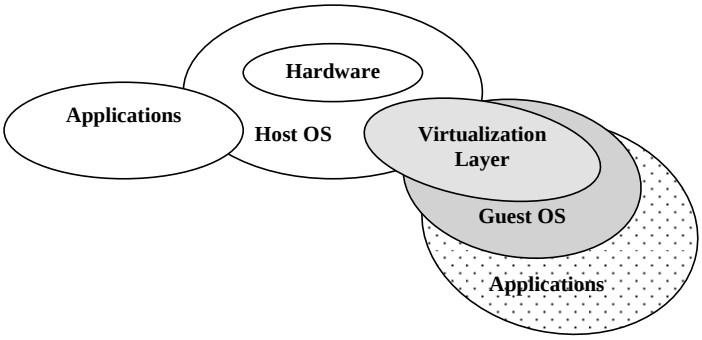

Fig.2. Hosted architecture

A ***hypervisor architecture*** (Figure 3) considers the virtualization the first layer of software installed on a clean x86-based system (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.

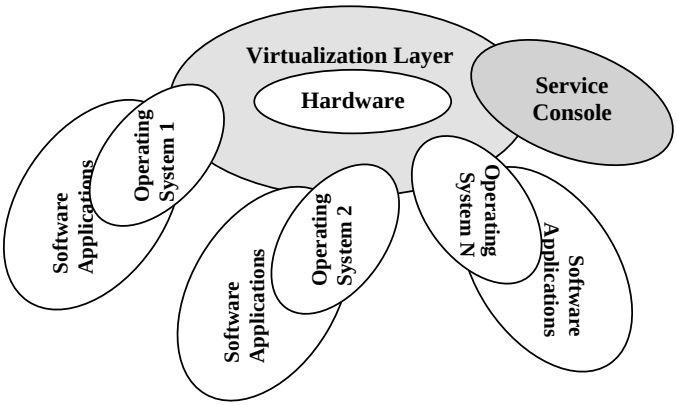

Fig.3. Hypervisor architecture

This approach has a virtualization central kernel (Virtualization Layer) and a Service Console for applications. Hypervisors can be designed to be powerful 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.

Another approach for virtualization is ***application-level partitioning***, in which 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.

The second architecture presented in this chapter has a great performance, because it provides advantages beyond partitioning, several system resources can be virtualized and managed, including CPUs, main memory, and I/O, in addition to having an inter-partition resource management capability (service console).

While partitioning is a useful capability for IT organizations, true virtual infrastructure delivers business value well beyond that.

3. How to run several OS on a single PC?

In the informatized business environment, small and mid-sized businesses are looking for cost-effective ways to add newer and richer applications to help and grow their businesses. They want access to the latest technology, but often don't have money or need for multiple servers running more than one OS. Using server's and workstation's virtualization, they change the way to manage IT resources and deliver technology to their partners and customers. An example of virtualization is multiprocessing computer

architectures. This is the practice of partitioning one server to appear as multiple servers. Add virtualization software [4] such as VMware Server and Microsoft Virtual Server, and one physical machine can run multiple operating systems and therefore a broader, richer set of business applications.

Today, VMware software on HP platforms seems to be the best solution of a virtualized IT environment. VMware began x86-based virtualization in 1998 and continues to be the innovator in that market, providing the fundamental virtualization technology for all leading x86-based hardware suppliers. The company offers a variety of software-based partitioning approaches, utilizing both hosted (**VMware Workstation** and freeware **VMware Server** and **VMware Player** products) and hypervisor (**ESX Server**) architectures [4].

VMware's virtual machine (VM) approach creates a uniform hardware image – implemented in software – on which operating systems and applications run. On top of this platform, VirtualCenter provides management and provisioning of virtual machines, continuous workload consolidation across physical system. VirtualCenter is the virtual infrastructure management software that centrally manages an enterprise's virtual machines as a single, logical pool of resources. With VirtualCenter, an administrator can manage dozens of Windows NT, Windows 2000, Windows 2003, Linux and NetWare servers from a single point of control. VMware supports Windows 95/98/NT/2000 /2003/XP, Linux (Red Hat, SuSE, Mandrake, Caldera), Novell (NetWare 4, 5, 6) and Sun Solaris 9 operating systems.

VMware is designed to ensure compatibility with customers' existing software infrastructure investments, which includes not just operating systems, but also software for management, high availability, replication, multipathing, and so on [5].

The ***Vmware's Workstation*** software makes it simple to create and run multiple virtual machines on a desktop or laptop computer. It can convert an existing physical PC into a virtual machine, that represents a complete PC, including the memory, network connections and peripheral ports.

VMware Workstation gives to the virtual machines the possibility to run Windows, Linux and a host of other operating systems side-by-side, on the same computer. The user can switch between operating systems instantly, share files between virtual machines with drag-and-drop functionality and access all the PC's peripheral devices.

VMware Player is available free of charge to run guest virtual machines produced by other VMware products: it cannot itself create new virtual machines. VMware provides free virtual disk images of several pre-configured operating systems and applications, many of them community-contributed. Freeware tools and websites (EasyVMX) also exist for creating VMs, mounting, manipulating and converting VMware disks and floppies, so VMware Player users can create, run and maintain virtual machines free of charge (even for commercial use).

VMware Player also forms part of the VMware Workstation distribution, for the purpose of site-wide installations with client users not licensed to use the full VMware Workstation product [1].

VMware Server can create, edit, and play virtual machines. It uses a client-server model, allowing remote access to virtual machines, at the cost of some graphical performance (and 3D support). In addition to the ability to run virtual machines created by other VMware products, it can also run virtual machines created by Microsoft Virtual PC.

The practical part of the article covers installation of the free virtualization product from VMware Inc., called VMware Player, on a Windows machine, running the Microsoft Windows Server 2003 SP2 operating system. The Player uses a special driver as a separate virtualization layer between the host OS and the guest OS. In the figure below there is an instance of the free operating system ReactOS, a project that tries to replicate the Windows XP family systems on an open source basis.

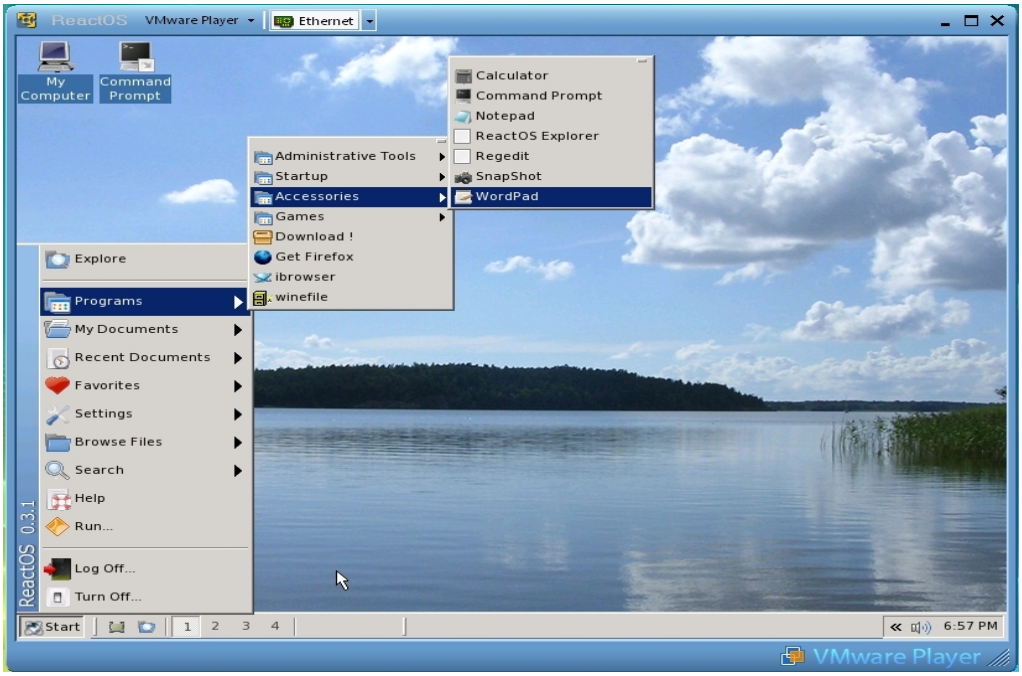

Fig.4. ReactOS running on the Windows™ version of VMware Player

The Player has the ability to run also Unix-like operating systems, like Linux or Solaris. In the image below we have a virtual appliance called Nagios-on-CD, based on Debian GNU/Linux. Using the virtual network adapters installed by VMware Player, the system running in the virtual machine can access the local network in a normal way.

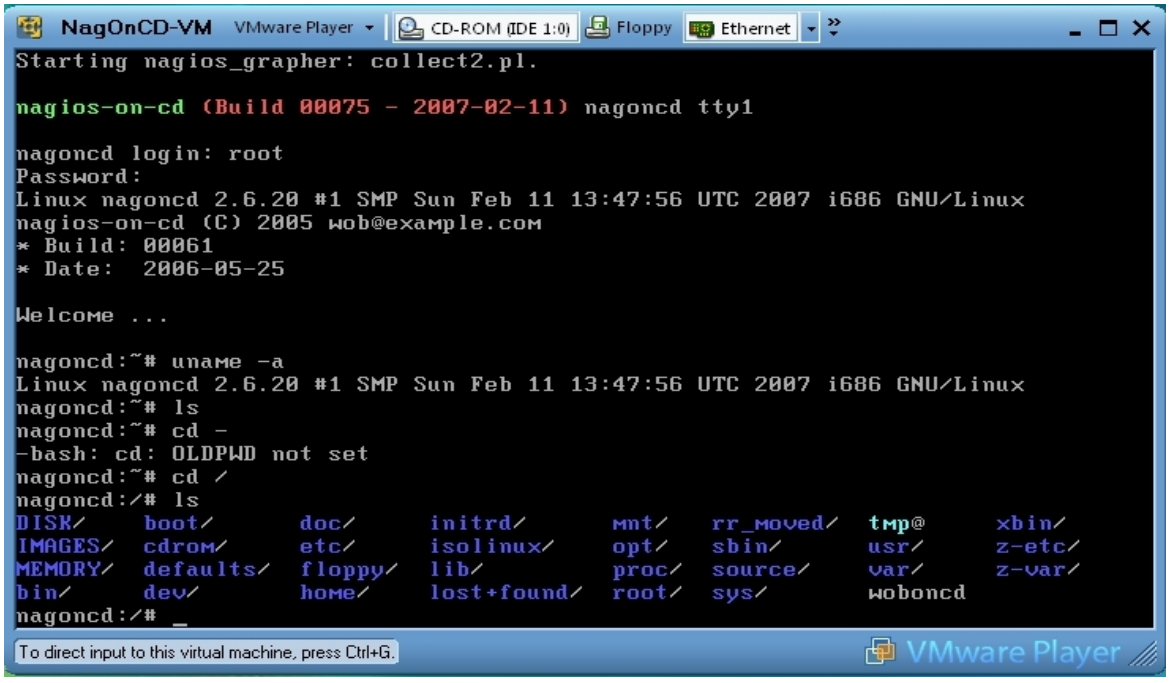

Fig.5. A Debian-based appliance running on the Windows™ version of VMware Player

4. Conclusions

Virtualization is an approach to IT that pools and shares resources, so utilization is optimized and it's the convergence of business need and technological innovation that can create real, new business value. This new technology is designed to improve resource

utilization, lower costs, and increase business agility.

Server virtualization solutions are helping small and medium-size businesses switch to newer, richer applications at a lower cost, while at the same adding security, disaster recovery, and more computing power. With virtualized server resources, a company can respond faster to business change and increase the efficiency of its operations.

Virtualization has a wide range of applications:

- Virtualization is useful to maintain the availability of critical applications, reduce the risk of data loss and business interruption, and recover more quickly from errors.
- Test and development processes - a single physical server can host many of virtualized development environments, reducing the number of physical servers needed for test and development.
- Legacy application and operating system support - the virtualization solution allows the company to upgrade to a new hardware platform while continuing to run legacy applications without modification inside a virtual machine.
- Client consolidation - the virtualization solution simplifies client software updates and management of security issues.

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