Server Virtualization with VMware vSphere 4

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The server virtualization market is expanding rapidly as customers seek savings in both space and energy through efficient use of hardware resources, an increase in business agility through prompt addition and removal of servers, and a reduction in the total cost of ownership (TCO) by separating hardware and business-system life cycles. The virtualization solution offered by Fujitsu and used by a large number of its customers in Japan combines Fujitsu's high-reliability servers and middleware products, which optimize data center operations, with vSphere 4, VMware's virtual infrastructure. This paper describes the transition of VMware's server virtualization products over the years, the functions and features of the vSphere 4 virtual infrastructure, its relation to cloud environments, and examples of using Fujitsu middleware with vSphere 4.

1. Introduction

The server virtualization market is expanding rapidly as customers seek space and energy saving through more efficient usage of hardware resources, greater business agility through prompt addition and removal of servers, and lower total cost of ownership (TCO) through separation of hardware and business-system life cycles.

VMware, Inc.,[1] headquartered in Palo Alto, California, is a virtualization software vendor with approximately 190 000 customers worldwide and about 6000 customers in Japan (as of October 2010). Its most recent product offerings for building and operating server virtualization environments are VMware vSphere 4 and VMware vCenter Server (respectively referred to as "vSphere 4" and "vCenter" hereafter).

Fujitsu started providing VMware products in 2006 and has since been providing its customers with virtualization solutions by combining these products with its own high-reliability servers as well as its middleware products for optimization of data center operations. These solutions are deployed by more than 1200 customers (as of November 2010). Fujitsu has abundant customer experience with these virtualization solutions and has released three case studies regarding cloud systems, which are currently attracting considerable attention.

- In-house Case Study 1: "Deployment of VMware vSphere 4 and Enhancement of On-Demand Virtual Environment Hosting for SaaS Providers"[2]
- In-house Case Study 2: "Putting the Cloud Into Practice: Numazu Software Development Cloud Center"[3]
- Oita Prefecture Case Study: "Virtualization of Mission-critical Systems by PRIMEQUEST, PRIMERGY, and VMware vSphere 4 toward Creation of a Public Sector Cloud"[4]

Fujitsu's server virtualization solutions are based on a number of server virtualization products (such as VMware, Hyper-V, RHEL-Xen, RHEL-KVM, and XenServer). From among

these, this paper describes the transition of VMware server virtualization products over the years and introduces the functions of VMware's latest product, vSphere 4.

2. Transition of VMware server virtualization

This section introduces how VMware's server virtualization has changed, focusing on two aspects—the "hypervisor" and the "virtualization product." The hypervisor, occasionally referred to as "VM monitor," is a control program designed to enable the creation and control of virtual machines (VMs). As shown in **Figure 1**, VMware's hypervisor product (shaded boxes in the figure) has evolved through three main phases.

1) VMware GSX (GSX)

The GSX hypervisor runs as an application on a general purpose OS (the "host OS") on hardware [1) in Figure 1]. In this setup, the host OS is in charge of I/O processing, which enables the hypervisor itself to have a compact configuration. However, this type of hypervisor suffers from overhead and extensibility problems. Like VMware Workstation, it is optimal for PC virtualization.

2) VMware ESX (ESX)

The ESX hypervisor runs directly on "bare metal," i.e., hardware—which is currently the most popular form [2) in Figure 1]. It features higher performance than GSX and has a console OS (COS) for hypervisor management. Client management is done by vSphere Client, and adding vCenter simplifies management of multiple ESX hypervisors. Since COS is Linux-based, it must be frequently patched, thus security is one challenge that it presents.

3) VMware ESXi (ESXi)

ESXi, the latest hypervisor of VMware, does not have a COS [3) in Figure 1]. As with ESX, vSphere Client is used to perform management tasks. While maintaining the same capabilities as ESX, ESXi is more compact since it has no COS, is easy to install and configure, and does not require COS patches (which reduces security risks).

As summarized above, VMware's hypervisor has evolved into a compact and high-performance product with easy-to-install features.

Figure 2 shows the evolution of VMware's virtualization products.

1) VMware ESX Server 2.x

This product enables resources on an ESX-installed server (ESX server) to be shared among VMs. Centralized management of multiple ESX servers is provided by vCenter.

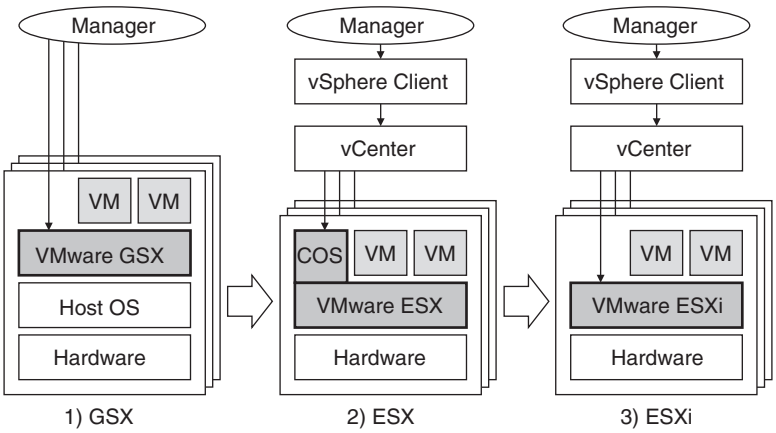

Figure 1
Evolution of VMware's hypervisor server virtualization product.

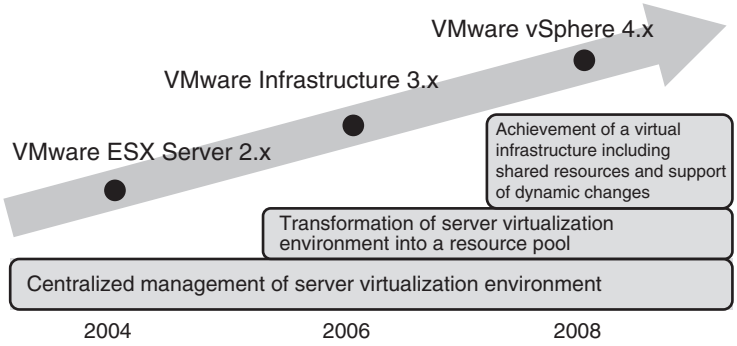

Figure 2
Changes in VMware's server virtualization environment.

2) VMware Infrastructure 3.x (VI3)

Adding the concept of resource pooling to VMware ESX Server 2.x, VI3 has enhanced overall capabilities. The CPU and memory resources of multiple ESX servers can be managed as a resource pool, enabling them to be handled as a single resource pool.

3) VMware vSphere 4.x

This product has significantly enhanced functionalities compared to those of VI3. It broadens the management scope to include network resources and shared storage and enables management of server, network, and storage resources as a single virtual infrastructure. It is better able to deal with dynamic hardware changes and enables agile modification of the ESX/VM configuration in accordance with resource requirement changes.

As described above, vSphere 4 represents the evolution of VMware's server virtualization products in two major streams: a) more compact, high-performing, and easy-to-install hypervisor and b) strengthened adaptability to system changes. In other words, vSphere 4 is suitable for environments such as the cloud, where agile creation and operation of systems is required.

3. Functions and features of vSphere 4 virtual infrastructure

In this chapter, we will dive into the functionalities and features of vSphere 4.

vSphere 4 enables users to chose either ESX or ESXi as the hypervisor and to create a virtual infrastructure having the following features.

1) Wide management scope

In general, this kind of infrastructure virtualizes and pools together physical resources and provides VMs with virtualized CPUs, virtualized memory, virtualized networks, and virtualized disks. On top of that, vSphere 4 enables dynamic and detailed management, including resource allocation, configuration change, priority control, and access control.

2) Flexibility

vSphere 4 provides a variety of functionalities such as dynamic addition of virtualized CPUs and virtualized memory (Hot Add), dynamic reconfiguration of virtualized disks and networks (Hot Plug), dynamic extension of virtualized disks (Hot Extend of Virtual Disks), and dynamic load balancing of network I/O. These functions enable elastic business operations—responding flexibly to service requirements and hardware changes without disrupting services provided by VMs.

3) Benefits for applications

vSphere 4 also provides advanced functions such as ones for ensuring business continuity (vMotion and Storage vMotion enable the moving of resources point-to-point [P2P] without disrupting the operation of VMs), automatic

load balancing (DRS: Distributed Resource Scheduler), and automatic VM reboot upon server failure (HA: VMware High Availability). Since these functions are part of the virtual infrastructure, there is no need to reconfigure the OS or applications running on the VMs—they can be used as is.

4) Integrated management

vSphere 4 provides useful features and extensive function groups for creating and operating virtual infrastructures. With these functionalities, vSphere 4 has always been a step ahead of other hypervisors.

Table 1 lists the major function groups, individual functionalities, and descriptions for vSphere 4. For further details, please check VMware's public web page.[1)]

The virtual infrastructure is integrally managed by vCenter. This enables system managers to manage almost all management tasks through the vSphere Client graphical user interface (GUI), which displays each management function in icon form for easy operation, enabling the entire virtual infrastructure to be managed as a single environment, just like Windows control panels (**Figure 3**).

Fujitsu provides middleware products that enable optimization of data center operations.

Table 1
Main functions provided by vSphere 4.

Categories and Functions			Description
vCenter Server			Integrated management of virtualization environment
vSphere 4			Virtualization platform
Infrastructure services			Virtualize and aggregate hardware resources
	vCompute	ESXi, ESX	Hypervisor
		DRS (Distributed Resource Scheduler)	Hypervisor load balancing
		DPM (Distributed Power Management)	Hypervisor power management
	vStorage	Thin Provisioning	Allocate virtual disks only as needed
		VAAI (vStorage APIs for Array Integration)	Enhance performance by using storage equipment functions
		Storage I/O control	Access priority control
	vNetwork	vDS (vNetwork Distributed Switch)	Virtual network across hypervisors
		Network I/O control	Access priority control
Application services			Service level controls for applications
	Availability	vMotion	Move running VMs to another hypervisor
		Storage vMotion	Move virtual disks of running VMs
		HA (High Availability)	Automatically restart VMs in event of server failure
		FT (Fault Tolerance)	VM redundancy to prevent downtime
		DataRecovery	D2D backup solution
	Security	vShield Zones	Firewall functions for VMs
	Scalability	Hot Add	Enables CPU and memory to be added to VMs as needed
		Hot Plug	Enables virtual disks and network devices of VMs to be changed as needed
		Hot Extension of Virtual Disks	Enables virtual-disk storage of running VMs to be extended
Others			—
		Host Profiles	Manages hypervisor settings
		Update Manager	Manages hypervisor updates
		Orchestrator	Automatically executes vCenter tasks
		Converter	Makes P2V/V2V conversions

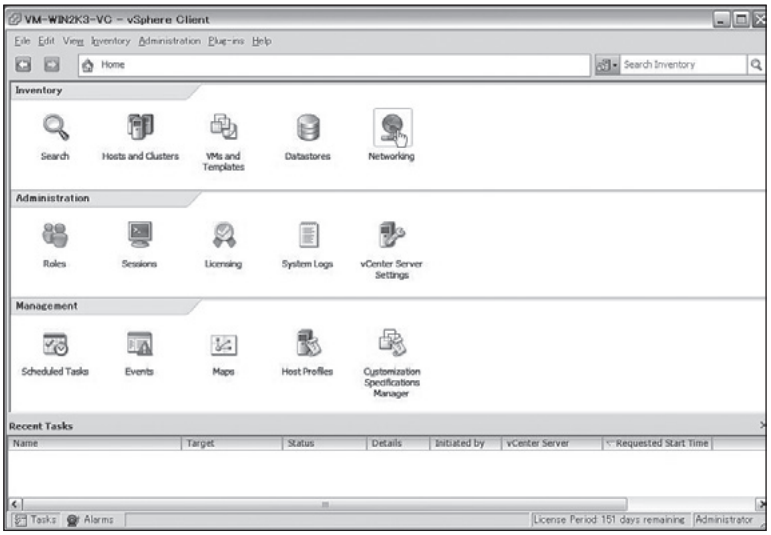

Figure 3
Screenshot of vSphere Client.

By aligning vSphere 4 with these Fujitsu products, users can enjoy an even more advanced and flexible virtual infrastructure.

4. vSphere 4 and cloud environments

Taking infrastructure as a service (IaaS) as an example (typically lending and aggregation of VMs), the role and responsibility of vSphere 4 in cloud environments is set forth below.

To acquire physical machine resources, users generally go through a process of budget, *ringi* (the process of obtaining management approval for a plan by circulating a draft prepared by the plan originator), and purchase, so it may be several months before the equipment is actually deployed. To acquire VM resources, users usually go through a simple process of application, content review, resource adjustment, VM creation/configuration, and provisioning, as long as the amount of resources requested does not exceed the amount available from the computing pool. If it does exceed the amount available, the procedure for acquiring physical machine resources is followed. Though it depends on resource availability and the skill of the IT manager, a new VM can usually be created within several days.

With vSphere 4's management uniformity and configuration change flexibility, it is relatively easy to acquire VM resources.

IaaS virtually automates VM creation and service provisioning. However, providing virtual infrastructure as a service and automating virtual infrastructures are not the whole story—there are several difficulties, as described below.

The HA function can be used in cloud environments such as IaaS to improve the level of service by minimizing service downtime upon server shutdown. An overview of HA is shown in **Figure 4**. The HA function detects a failure in an ESX server through mutual monitoring between ESX servers, which exchange "heartbeats" via the network. When a failure is detected [1) in Figure 4], it automatically reboots the VM that had been running on the failed ESX server on another ESX server [2) in Figure 4]. An acceptable level of availability can therefore be obtained without having to reconfigure the virtual OS or applications running on the VM.

However, as the system is based on "mutual monitoring," a procedure is needed to ensure normal and safe shutdown of all ESX servers. Such a procedure consists of VM

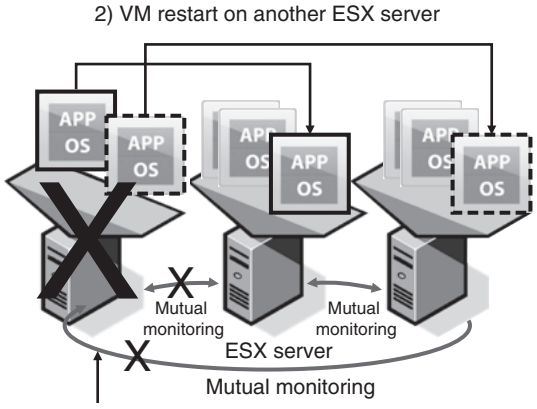

Figure 4
Overview of VMware's High Availability function.

shutdown (shutdown of OS and applications on each VM), switching of ESX servers to maintenance mode, and shutdown of each ESX server. In other words, this procedure affects business task procedures and requires the use of a mutual monitoring mechanism. Failure to follow this procedure results in problems such as the need to reconfigure the HA function after rebooting. Moreover, system problems result if the shutdown procedure is not concluded in time after the onset of a power outage due to a large number of ESX servers being deployed or a lack of uninterruptible power supply (UPS) capacity.

Fujitsu's "Systemwalker Runbook Automation" middleware product is a great solution to these problems. Upon notification of a power outage, it automatically executes the 'safe shutdown' procedure for all ESX servers and completes the shutdown while the UPS is still up, and, as a result, averts system problems. In addition, it ensures a timely and swift system reboot after power is restored.

Although the above may seem a worst case scenario, it illustrates how system operations easily performed manually in a conventional virtualization environment using only vSphere 4 may be difficult in a virtualization environment that assumes automation, such as the cloud.

Given its extensive experience and considerable expertise, Fujitsu is fully equipped and capable of addressing and providing a variety of solutions (from the creation of cloud environments to the solving of operation problems like the ones described above) by optimally combining vSphere 4 with Fujitsu middleware.

5. Conclusion

The vSphere 4 product is certainly well suited for the emerging cloud era, in which flexibility and agility are the keys to success.

Fujitsu will continue to provide and support VMware products in combination with Fujitsu's highly reliable servers and middleware, which are essential to data center optimization, and, as a result, contribute to the virtualization market and most importantly to our customers' business expansion.

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