Server Virtualization:

Delivering sustainable cost reduction by increasing server efficiency and enabling the transition to a cloud-ready architecture.

Continuous and sustained reduction in both capital and operating costs remains a key priority for the CIO. For this reason, most enterprises are already along the path of consolidating, rationalizing, standardizing and centralizing their infrastructure. Virtualization takes this a stage further, offering the CIO an opportunity for large reductions in both capital and operating costs through hardware reduction. Furthermore, Cloud-readiness is almost implicit in a virtualized environment, as once you have decoupled the services from the underlying infrastructure, the required resources can be provisioned from the cloud.

A recent Capgemini project found that utilization rates at a large media firm, with a well-run and consolidated data center, were around 30%. Virtualization of 90% of applications on these servers allowed the removal of over two thirds of the machines. Given that the servers were being housed in prime city locations, the benefits in terms of office space, power consumption, cooling and maintenance quickly yielded a positive return on investment. In addition, owing to the need to rapidly scale this environment once a day, cloud computing functionality was added to the virtualized solution to cope with these demands at peak times, which helped maintain speed and service quality.

Virtualization technologies have been around since the 1960s, so why have organizations been so slow to take full advantage? This is mainly because there are some additional issues in set-up and maintenance that must be considered when migrating to virtualized infrastructure. Not only can these issues be overcome, but the resulting highly-efficient virtualized estate facilitates a reduction in maintenance requirements.

This paper articulates the benefits of server virtualization—moving beyond pure cost to increased flexibility and reliability—and outlines the key risks and issues that CIOs should consider before embarking on this important step on the journey to the cloud.

Virtualization Explained: Why server virtualization should be the first step

There are many forms of virtualization and they are all based on the same concept; virtualization technologies place a separation layer between the physical hardware component and the services that require this component to function.

Figure 1, below, illustrates how IT components offer services to a virtualization layer, and in turn, how services communicate with this layer. Both the IT component and the service can be changed without compromising the environment.

This separation of services and hardware is due to a piece of software that appears to the service as though

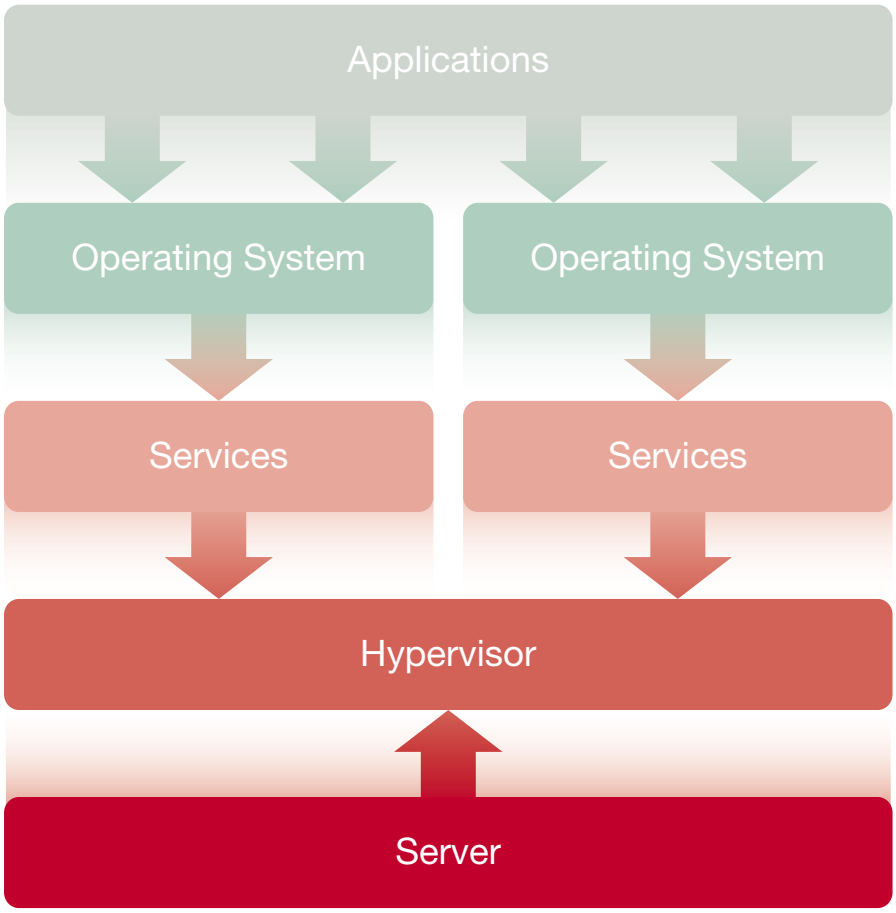

Figure 1: The concept of virtualization

it is comprised of usual hardware components (e.g. CPU, memory, etc) when, in reality, they sit at the next level down under the hypervisor, which is sometimes called a virtual machine monitor (VMM). The hypervisor manages communication between a service and the underlying physical hardware.

Virtualization is applicable in many areas of the IT environment:

- Network: By applying virtualization in a network the available resources, for instance bandwidth or connection, are hidden from the service using it. In this way, multiple services share the same bandwidth;
- Storage: The virtualization of storage means that the available storage (and the location of this storage) is hidden from the service that requires it. For example, a single physical disk can flexibly run multiple file-systems to support different operating systems without the need to fix partitions or file systems up front, or many disks can be banded together to provide this functionality as requirements grow;
- Server: Services running on a server are interacting with the resources available in the server hardware (CPU, memory, network card, etc). By placing a virtualization layer on top of the hardware, the available resources become invisible to the service and can even be shared;
- Desktop: The operating system environment can be completely or partially virtualized, allowing either a single 'fat' terminal containing high-spec storage and processing hardware to run multiple desktops, or a 'thin' terminal containing only bare-bone hardware to access more powerful shared system resources at a server.

From an infrastructure cost benefit and return on investment perspective, server virtualization is the most interesting of the four types described above; it allows for increased resource usage, it reduces the investment in hardware and, by definition also includes aspects of storage virtualization. The remainder of this paper focuses on server virtualization.

In the case of server virtualization, the service is decoupled from the hardware to enable multiple operating systems or applications to run in their own secure container on a single server, while still appearing to be running in their own physical environment. For example, you could run a CRM platform and a Payroll service at the same time on the same physical machine, or you could run both Windows- and Linux-based operating systems on the same physical machine. The user still receives an experience that is equivalent in its speed and presentation to having a dedicated piece of hardware. The virtualization layer controls the number of resources assigned to a specific service, which is configured up front.

An application or operating system can be offered 'as a service', meaning that the underlying hardware layer can be taken as given and invisible to the user. Some of the most prominent virtualization software solutions include those by VMware, Citrix and Microsoft. VMware was the first in the marketplace in the late 1990s, with Microsoft beginning to offer virtualization functionality in 2003 and Citrix most recently in late 2007, following the purchase of the opensource Xen solution.

Selection of the appropriate solution vendors is key to the success in building virtualized infrastructure, as the solutions vary in their support for different operating systems and hardware platforms. Both the current position and future plans for the infrastructure must be carefully considered against the options available.

The Benefits of Server Virtualization

There are three main areas in which server virtualization can bring benefits to organizations:

Capital Expenditure Reduction: The outlay on new hardware is reduced because virtualization ensures that each piece of hardware purchased is utilized closer to full capacity. In turn, fewer servers reduce the space required in datacenters.

Operating Expenditure Reduction: These savings come in the form of power savings (cooling and powering less hardware, despite the fact that remaining machines will be drawing slightly more on a machine basis due to higher utilization) and staffing reductions enabled through increased automation and fewer servers to maintain. The power saving is also directly linked to an associated carbon saving for the business. By automatically moving active services to a minimum number of physical servers required to run them, the remainder of the servers can be switched off. The latest Intel processors within servers can also automatically switch off unused cores, preserving energy on the processor level.

Increased Flexibility and Responsiveness: New services can be more quickly provisioned, as hardware does not need to be ordered and set-up to provision a new virtual machine.

Virtualization technology has an impact on the potential costs, benefits and business models of traditional outsourcing arrangements. For existing outsourcing clients, it can provide an opportunity to provide cost savings over and above the traditional year-on-year efficiency gains incorporated in typical outsourcing deals, the benefits of which can be shared between the client and provider. For new outsourcing clients, virtualization can form part of a transformation of the server estate at the inception of a contract providing a 'one hit' cost benefit when assets are transferred on top of the usual year-on-year savings.

Server Virtualization—Understanding the evolution

There are three evolutions of server virtualization, each differing in sophistication, but in turn offering added efficiency, security and resilience. The three steps correspond roughly to the development over time of this technology.

Single Server: Where a dedicated server contains a hypervisor supporting one or a number of dedicated services. The hypervisor is the hardware or software that separates the existing services (e.g. CRM service) from the underlying hardware, letting each application think it is running on its own physical machine. In this most basic form, the service being provided is still server-bound. Although this represents virtualization in its most basic form, it already renders a large amount of hardware obsolete because a modern server can support the equivalent of about 60 virtual machines.

Multiple Servers—Common Instruction Set, Manual Management: Here the virtualization layer—the hypervisor—can allow the virtual machines to move from one physical server to another, thus creating a manually operated virtualized server farm. This allows the services sitting on top of the hypervisor to be moved from one physical server to another. This can be beneficial if more flexible control utilization is required, for instance when the CPU usage is over a certain threshold, as it enables services to be moved to another, less utilized machine to maintain full-performance of the service. The maximum available resource for a single service is bound to the available physical resources on a specific server. Movement of services is done manually, leaving the server/service relationship dedicated. This repositioning of services requires the operating system and application to be installed on a shared central storage system.

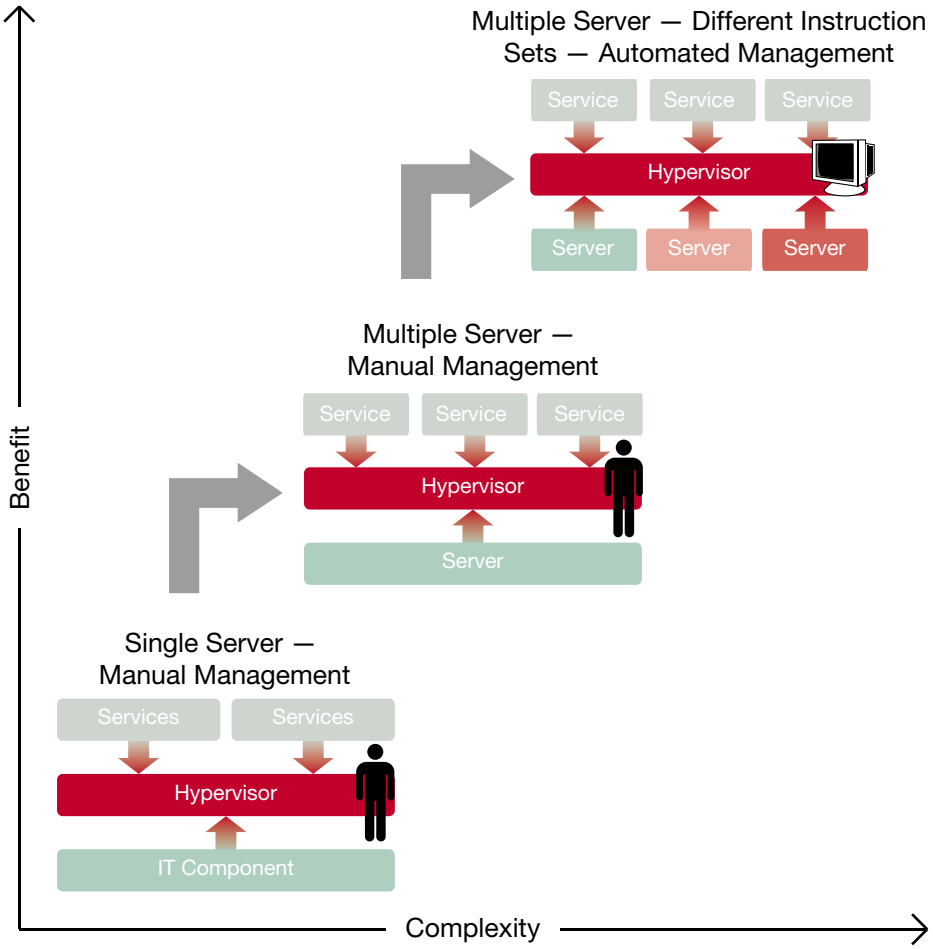

Figure 2: Virtualization Options

Multiple Servers, Diverse Hosts and Automated Management: The most advanced option available, vMotion with FlexMigration, represents the likely direction of the server virtualization market in the future. Until recently, virtual servers could only run over machines with identical 'Instruction Sets'—a term that describes the architecture defining the data types, instructions, registers, addressing modes and memory architecture, amongst other things, in a physical system—vMotion with FlexMigration changes this.

The virtual infrastructure is extended across a number of underlying server machines (which can have different Instruction Sets), but the intelligent management software is smart enough to provision new services on-demand or to move services to different parts of the server farm to maintain performance. These automation rules can be based on a number of variables, for example Resource Usage (CPU, Memory, etc), server maintenance hours, or backup. Automated management can be extended by use of a Self Service Portal, where end-users are able to request a service, which is then initiated. Paying for services on a Pay-per-Use basis completes the Service Oriented Infrastructure.

Currently, this service is only available using Intel hardware in combination with VMWare software. Citrix XenSource, Parallels, Microsoft Hyper-V and Opensource Xen, KVMt. However, a wider range of options are likely to be available soon.

Server Virtualization—The Issues

There are four main issues that must be considered to ensure the success of a server virtualization programme. By understanding these issues, CIOs will be able to release the potential value that virtualization can offer.

Gaining Acceptance from the Business

Without virtualization, applications in organizations typically run on dedicated servers. In most cases these servers sit within the business unit using their services. In the case of virtualization, the server instances could be running on a virtual server farm or on a physical local server that is shared by other applications. It is crucial to ensure that the concerns of the business around aspects such as security are met. In addition, a clear business case explaining and demonstrating the costs and benefits, including the effect of balance sheet implications of retiring depreciating hardware early, and creating the necessary business buy-in to get the project started, is key.

Changing the Governance Model

Firstly, a new cost model is needed when considering server virtualization. In a virtualized model, many departments or business units share physical servers, therefore, the IT department needs to purchase the physical servers, whereas previously they would be paid for by the business needing them. Secondly, ownership and Information Lifecycle Management (ILM) become key to tracking and managing the number of virtual machines being requested and provisioned. The risk of not doing this effectively creates 'virtual sprawl' in which the number of unused virtual machines, which have been switched on but are sitting idle on the server because they are not being used, grows exponentially. Despite being able to run a number of virtual machines on one server, if the machines are not actually being used, the utilization benefits of virtualization will not be fully realized.

Preparing the IT Department for Change

Alongside the business change, the IT department should also prepare for change. First, it must be able to deal with the direct changes—such as physical to virtual migration processes, maintenance procedures and security. Second, there are some fundamental architectural concepts that differ in a virtualized world. For instance, backup and restoration are different in a virtualized environment, as are clustering and disaster recovery. In some cases, virtualization makes things easier (for example reducing the number of physical machines that need to be built, managed and maintained), but in others simple functions become more complex (for example, building a single physical machine to ensure that it can accommodate the requirements of multiple virtual instances and installing the virtualization layer).

Application Assessment and Rationalization

The process of server virtualization should begin with a detailed assessment of the applications portfolio. First, it is an opportunity to improve efficiency across the business by standardizing applications and versions and retiring applications that are no longer being used or have been replaced. Second, the level of virtualization that can be achieved is highly dependent on the compatibility of the application portfolio. Not all applications are compatible, either due to the lack of support by the vendor or the need for intensive use of certain application resources. For example, applications that require high bandwidth exchange with physical hardware, perhaps for high-intensity processes, tend to raise problems in a virtualized environment. Also, not all software vendors have adjusted their license structures to allow for virtualization—which could result in higher license costs, the need for entirely new license procurement, or additional support.

Technical Issues

New technical issues emerge when introducing server virtualization into the enterprise, they roughly group into four categories of risk management, backup, disaster recovery and vendor lock.

Because of the reduction in overall server numbers, virtualized servers will become more consolidated and centralized. While this is positive from an efficiency perspective, it introduces a risk for contingency planning, because the mitigating factors of location and hardware diversification are reduced. Since a virtual service is treated as a single file, getting the information out of that file, say for back up purposes, can be difficult. However, if you instead back up the service file itself, not only do you back up the files it contains but you also have a snap shot of the entire service for disaster recovery purposes. By moving the service files to a recovery infrastructure (which given the utilization gains made through virtualization should not be a problem to set up), either as a tape backup or via storage synchronization, services can be back up and running in a very short space of time.

Service files are not interchangeable over hypervisor solutions. Selection of the right vendor for an organization's unique mix of applications and infrastructure is crucial as changes are difficult.

Server Virtualization—Tackling the Opportunity

Before embarking on a programme of server virtualization, organizations must examine their current estate and application portfolio in detail, and make a clear link between the shape and requirements of the future business, and the services that will be needed. The steps to be taken are:

An analysis and discovery phase to understand:

- Inventory of assets (hardware, software/application portfolio and associated licences);
- Staffing levels, activities and skills;
- Services currently provided and the required service levels;
- Corporate strategy and organization demands to projected future demands for services (for example: geographic, functionality or complexity).

Planning and architecting options:

- Prioritize areas for virtualization and clearly state where it is not appropriate;
- Calculate and evaluate the business case for moving applications that cannot be virtualized;
- Construct a business case around proposed solutions;
- Re-examine staffing levels, capabilities and governance required and plan necessary changes to accommodate future needs;
- Re-evaluate and plan for business continuity and security arrangements;
- Construct a migration and implementation plan;
- Test and refine virtualized design.

Implementation:

- Implement planned solution;
- Make improvements and changes where problems are encountered or new opportunities become apparent;
- Benefits tracking to prove business case;
- Service quality tracking;
- Security and continuity audit in new state.

Server Virtualization is a compelling instrument to reduce cost. Through increasing utilization and by allowing a reduction in the number of servers and a reduced need for staffing and maintenance, a substantial financial saving can be achieved. The reduction in electricity usage means an additional carbon reduction benefit.

Additional benefits include increased flexibility and responsiveness and reduced data center power consumption. Full adoption of virtualization best practice principles can ensure that an organization's infostructure is cloud-ready allowing easier adoption of cloud technology in the future.

There are issues to be considered when adopting a virtualization solution, but the technology is sufficiently mature that, with the necessary experience technological expertise and planning, these hurdles can be overcome, and the rewards for doing so are significant.

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