Virtualization 101: Technologies, Benefits, and Challenges

A White Paper by Andi Mann, EMA Senior Analyst
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ENTERPRISE MANAGEMENT ASSOCIATES®

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EMA is the first, and only, Analyst firm specializing in the issues of IT Management – covering areas ranging from Virtualization to Configuration Management (CMDB) to Service Level Management to Security.

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Introduction

Virtualization – the technique of managing systems and resources functionally, regardless of their physical layout or location – is of growing importance to IT. Some areas are approaching significant maturity, such as storage virtualization or thin-client computing; others, such as application streaming, are just beginning to energize the market and reinvigorate the idea of virtualization. Overall, these many techniques are providing specific benefits in many areas. However, virtualization is also posing new and unique challenges, especially in system management.

This educational white paper from Enterprise Management Associates (EMA):

- Introduces the concept of virtualization
- Differentiates and defines the various virtualization technologies
- Reviews the key business drivers for and the benefits of virtualization
- Looks at some of the challenges of managing a virtual environment

What is Virtualization?

Virtualization is, at its foundation, a technique for hiding the physical characteristics of computing resources from the way in which other systems, applications, or end users interact with those resources. This includes making a single physical resource (such as a server, an operating system, an application, or storage device) appear to function as multiple logical resources; or it can include making multiple physical resources (such as storage devices or servers) appear as a single logical resource.

The Different Types of Virtualization

Part of the problem of the intangible enterprise is that there are so many different types of virtualization and confusion over their definitions. In this section, we define many of the key terms associated with virtualization.

Operating System Virtualization

Operating System Virtualization is a method of running multiple logical (or virtual) operating systems (aka "guests") on top of a fully functioning base (or "host") operating system. This method of virtualization usually uses a standard operating system such as Windows or Linux as the host, plus a virtual machine manager, to run multiple guest operating systems. This is illustrated in Figure 1 - Operating System Virtualization.

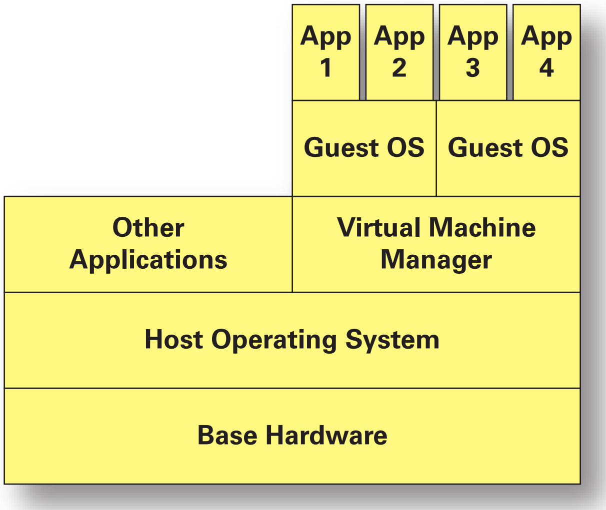

Figure 1 - Operating System Virtualization

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Server Virtualization

Server Virtualization (also known as "system virtualization") is where the base hardware is virtualized, allowing multiple guest operating environments to run directly on top of the hardware, without requiring a complete host operating system. Typically, virtualization software will run on the base hardware, and the operating systems will be installed onto that virtualization software. While this is most commonly referred to as "server virtualization," and most commonly used for larger servers, it is equally applicable to desktop environments. This is presented in Figure 2 - Server Virtualization.

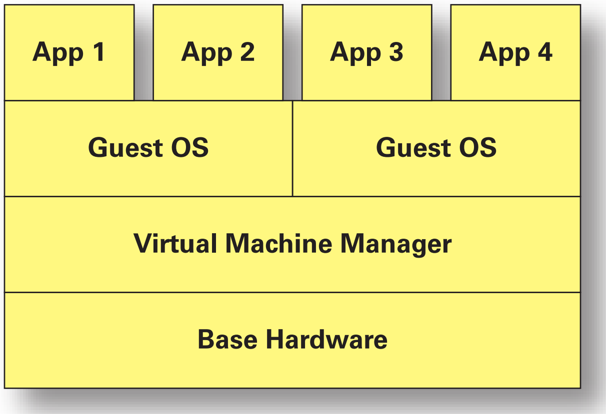

Figure 2 - Server Virtualization

Application Virtualization

Application Virtualization is where an application is provided to the end user, generally from a remote location (such as a central server), without needing to completely install this application on the user's local system. Unlike traditional client-server operations, the application itself is not necessarily designed to be used by multiple users at one time, and indeed is unlikely to be shared in the same way. Each user has their own, fully functional application environment, with few or no components actually being shared in the runtime environment.

Desktop Virtualization

Desktop Virtualization provides the end user with a desktop environment that in turn allows access to any authorized application, regardless of where the application is actually located. This allows an end user to have a single interface from which they can start or access their Web, local, and server-based applications, without needing to look through Web pages, the Windows Start menu, or their terminal services interface. The virtual desktop may be hosted remotely on a central server, giving the user access only to the applications available remotely; or it may be hosted locally, giving the user access to local, as well as remote, applications.

Streaming

Streaming is essentially a subset of other virtualization technologies that provides a way for software components – including applications, desktops, and even complete operating systems – to be dynamically delivered from a central location to the end-user over the network. Unlike traditional software delivery, however, the software component is usually available for use by the end user before the entire download has completed (much like video streaming) – there is no complex and lengthy installation process.

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Storage Virtualization

Storage virtualization provides a way for many users or applications to access storage without being concerned with where or how that storage is physically located or managed. For example, a single large disk may be partitioned into smaller, logical disks that each user can access as though it were a single network drive; or a number of disks may be aggregated to present a single storage interface to end users and applications. Typically storage virtualization applies to larger SAN or NAS arrays, but it is just as accurately applied to the logical partitioning of a local desktop hard drive.

Data Virtualization

Data virtualization abstracts the source of individual data items – including entire files, database contents, document metadata, messaging information, and more – and provides a common data access layer for different data access methods – such as SQL, XML, JDBC, File access, MQ, JMS, etc. This common data access layer interprets calls from any application using a single protocol, and translates the application request to the specific protocols required to store and retrieve data from any supported data storage method. This allows applications to access data with a single methodology, regardless of how or where the data is actually stored. This is represented in Figure 3 - Data Virtualization.

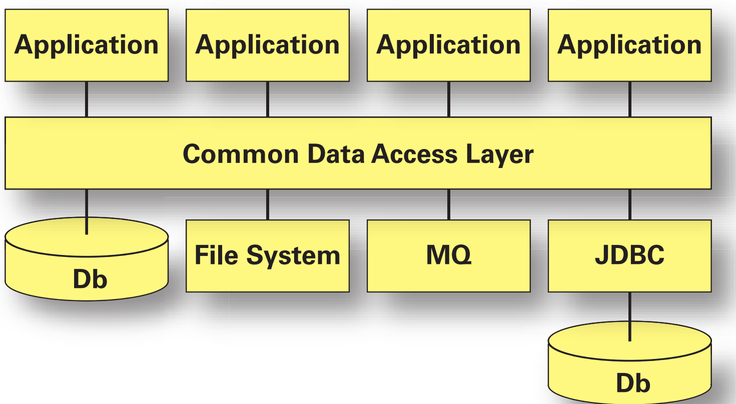

Figure 3 - Data Virtualization

Clustering

A cluster is a form of virtualization that makes several locally-attached physical systems appear to the application and end users as a single processing resource. This differs significantly from other virtualization technologies, which normally do the opposite, i.e. making a single physical system appear as multiple independent operating environments. A typical use case for clustering is to group a number of identical physical servers to provide distributed processing power for high-volume applications, or as a "Web farm", which is a collection of Web servers that can all handle load for a Web-based application.

Grid Computing

Like a cluster, a grid provides a way to abstract multiple physical servers from the application they are running. The major difference is that the computing resources are normally spread out over a wide network, potentially across the Internet, and the physical servers that comprise a grid do not have to be identical. Unlike a cluster, where each server is locally connected, is likely to be identical, and can handle the same processing requirements, a grid is made up of heterogeneous systems, in diverse locations, each of which may specialize in a particular processing capability. Much greater coordination is needed to allocate the resources to appropriate workloads.

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Software-As-A-Service

Software as a Service (SAAS) is an implementation of virtualization, where software is provided by an external application service provider (ASP), normally on a usage basis. Typically, the end user will access the software service through a Web browser and, in some cases, specialized software may still be required. The complete software application is not hosted locally, or even within the enterprise, but is hosted at a third-party service provider.

Thin Client

A thin client is a local system that has limited or no independent processing, storage, or peripherals of its own, relying entirely on a remote system for virtually all operations. Typically, a thin client will have limited local processing that allows it to merely send and receive I/O to a central server, which hosts the operating system, desktop, and applications.

The Benefits of Virtualization

There are a number of key business benefits that are driving enterprise IT organizations to adopt virtualization technologies. Some of the most significant drivers include:

- Business continuity and disaster recovery
- Flexibility and agility
- Server consolidation
- Reduced downtime
- Reduced administration costs

Other benefits of virtualization include a variety of security benefits (stemming from centralized computing environments); improved service level management (i.e. the ability to manage resource allocation against service levels for specific applications and business users); the ability to more easily run legacy systems; greater flexibility in locating staff; and reduced hardware and software costs.

Business Continuity and Disaster Recovery

Virtualization allows easier software migration, including system backup and recovery, which makes it extremely valuable as a Disaster Recovery (DR) or Business Continuity Planning (BCP) solution. Virtualization can duplicate critical servers, so IT does not need to maintain expensive physical duplicates of every piece of hardware for DR purposes. DR systems can even run on dissimilar hardware. In addition, virtualization reduces downtime for maintenance, as a virtual image can be migrated from one physical device to another to maintain availability while maintenance is performed on the original physical server. This applies equally to servers and desktops, or even mobile devices – virtualization allows workers to remain productive and get back online faster when their hardware fails.

Business Agility

Virtualization can greatly increase business agility and flexibility. By decoupling business processing from physical hardware, virtualization improves agility by enabling IT to respond to rapid changes in demand.

Virtualization also allows enterprises to be faster to deploy new products and services, more able to incorporate offsite, contract, and offshore labor, and more easily expand into new markets. There is a much lower hardware requirement for testing new applications. Developers can develop and test code side-by-side on multiple operating systems or applications, which will reduce development and testing time. They can also instantly reload their test bed from a golden image, which results in faster build/test/rebuild cycles (especially across multiple operating systems). Virtualization reduces mundane deployment processes for production implementation to minutes instead of days or weeks, reduces procurement time, and results in fewer hardware compatibility issues. It also allows enterprises to use a single central location for application updates, instead needing to touch many dispersed systems for each new application upgrade.

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Server Consolidation

Server consolidation and improved server utilization is another driver for virtualization adoption. Virtualization allows enterprises to combine the workload from multiple underutilized physical machines into a single physical system. This dramatically reduces the overall hardware spending, as it requires far fewer physical systems for the same application workload. It also has a dramatic effect on the overhead costs, including power, cooling, storage, and physical administration.

Reduced Downtime

Reduced downtime is another key driver for virtualization. Virtual images are easier to restore after a failure – either an operational failure (such as a virus infection) or a hardware failure. The portability of virtual images allows new and different hardware to be used for recovery, further reducing the downtime. Similarly, from an end-user perspective, desktop failures are critical, but with application and desktop virtualization, end-users are not tied to a specific (failing) desktop or location, and can get back to work on any machine very quickly, reducing the impact of any downtime.

Reduced Administration Costs

With virtualization, administration (especially remote administration) becomes a lot easier, faster, and cost effective. Desk-side visits can be almost eliminated through desktop and application virtualization, because the business applications are maintained centrally. Any failure in the end user environment can be rectified quickly and easily. In addition, virtual server operating systems can mostly be managed remotely using standard tools and network interfaces, rather than needing physical attention. For example, an administrator can use a remote management console to perform administration operations like system shutdown, power-down, and reboot, without ever actually affecting the host operating system or hardware. Server consolidation enabled by virtualization also reduces the number of servers that need administration. Virtualization can significantly reduce management and maintenance costs, especially for large user communities, and wide geographic networks.

The Challenges of Managing a Virtual Environment

While virtualization offers a number of significant business benefits, it also introduces some new management challenges that must be considered and planned for by companies considering a virtualization strategy.

The key management challenges for companies adopting virtualization include:

- Policy-based management
- Bandwidth implications
- Image proliferation
- Security
- Human issues

Some of the other challenges of deploying and managing a virtual environment include: a new level of complexity for capacity planning; a lack of vendor support for applications running on virtual systems; an increased reliance on hardware availability; cost accounting difficulties (i.e. measuring usage not just for physical servers but also for individual parts of a server); an additional layer of monitoring complexity; the potential for significant up-front costs; and an overall increase in the complexity of the IT environment.

Policy-Based Management

Enterprises should look to deploy automated policy based management alongside their virtualization strategy. Resource management, for example, should include automated policy-based tools for disk allocation and usage, I/O rates, CPU usage, memory allocation and usage, and network I/O. Management tools need to be able to throttle resources in shared environments, to maintain service levels and response times appropriate to each virtual environment. Administrators

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should be able to set maximum limits, and allocate resources across virtual environments proportionally. Allocations need to have the capability to change dynamically to respond to peaks and troughs in load characteristics. Management tools will also be required to automate physical to virtual, virtual to virtual, and virtual to physical migration.

Bandwidth Implications

Enterprises should make sure they have the appropriate network bandwidth for their virtualization requirements. For example, instead of one server using a 100Mb Ethernet cable, now 10 or even 100 virtual servers must share the same physical pipe. While less of a problem within the datacenter or for communication between virtual servers running in a single machine, network bandwidth is a significant issue for application streaming and remote desktop virtualization. These technologies deliver quite substantial traffic to end users, in most cases significantly higher than is required for standard-installed desktop computing. Streaming technologies, although in many cases more efficient than complete application delivery, also impose high bandwidth requirements.

Image Proliferation

Operating system and server virtualization can lead to a rapid proliferation of system images, because it is so much easier and faster to deploy a new virtual image than to deploy a new physical server, without approval or hardware procurement. This can impose very high management and maintenance costs, and potentially lead to significant licensing issues including higher costs and compliance risks. This proliferation also leads to significant storage issues, such as competing I/O and extreme fragmentation, requiring much faster and multi-channel disk access, and more maintenance time, effort, and cost. Enterprises need to manage their virtual environment with the same level of discipline as their physical infrastructure, using discovery tools to detect and prevent new systems from being created without following proper process.

Security

While virtualization can have many worthwhile security benefits, security also becomes more of a management issue in a virtualized environment. There will be more systems to secure, more points of entry, more holes to patch, and more interconnection points – across virtual systems (where there is most likely no router or firewall), as well as across physical systems. Access to the host environment becomes more critical, as it will often allow access to multiple guest images and applications. Enterprises need to secure virtual images just as well as they secure physical systems.

Human Issues

Enterprises should not underestimate the potential for human issues to affect their virtualization plans adversely. Virtualization requires a new set of skills and methodologies, not just within IT, but often (certainly in the case of application and desktop virtualization) in the end-user community. Perhaps most importantly, this new technology requires new and creative thinking, not just new training and skills.

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Conclusion

Virtualization, in all its forms, is a highly disruptive yet clearly beneficial technology. Enterprises are deploying virtualization for a number of real and significant benefits. The strongest driver – business continuity – is surprising, but many of the other drivers, such as flexibility and agility, server consolidation, and reduced administration costs, are fully expected.

Management of virtual environments is, by all accounts, a lot easier than might otherwise be expected. In the ITIL disciplines especially, it is marginally surprising to see how most organizations believe it will be easier to manage a virtual environment than a physical one. Nevertheless, there are significant challenges to be overcome when deploying and managing virtual environments. Amongst the most significant are training and staff development. Other management challenges are less apparent, but no less real. Policy-based resource management and capacity planning are a new challenge in a virtual world, requiring new technologies and processes.

Overall, it is clear that despite these challenges, virtualization is a mature technology that offers significant business benefits. Enterprises considering this technology should review the options and decide on the right course for them. They should also carefully plan their deployment, taking into account the potential costs, disruptions, and skill challenges

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- Analyze objective EMA solution profiles that cut through the hype
- Compare Virtualization solutions from dozens of vendors side-by-side

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