



WebSphere software

Extending virtualization in the data center with application infrastructure virtualization:

Introducing WebSphere Virtual Enterprise.

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Introduction

Virtualization helps businesses to simplify and consolidate their IT infrastructures. It also helps lower operational and energy costs as well as increase flexibility and agility. Businesses are increasingly adopting virtualization in their server farms, storage and networks to gain the benefits of simplification, consolidation and flexibility, which are the hallmarks of virtualization technologies. Although many of these organizations believe they've taken the virtualization road about as far as it can go in their data centers, they might not have tapped into a critical aspect of virtualization technology.

This white paper examines a new virtualization category in the data center called *application infrastructure virtualization* and how it can augment and enhance the value of server virtualization. This paper also describes IBM WebSphere® Virtual Enterprise, a product designed to virtualize enterprise applications and services across the IT infrastructure.

Virtual technology, real benefits

Intrigued by virtualization? You're not alone. For IT organizations managing multiple applications and infrastructure resources, it's an appealing idea from both a figurative and literal perspective. Figuratively, virtualization connotes good things. The very idea of it. It's not reality. It appears that you are getting more than you actually have. Who doesn't like virtual memory or a virtual network? Literally, companies are increasingly adopting virtualization techniques across their infrastructure, inspired by growing infrastructure costs related to environmental factors (such as power) and ever-present administration costs.¹ They are finding, however, that as its name implies, virtualization is more than just a vehicle for server consolidation and cost savings.

Virtualization has long been employed in IT systems; it's just that we haven't really noticed it. Take virtual memory. Although we enjoy the benefits of it on our notebook or desktop PC, virtual memory is used by an operating system (OS). Virtual I/O, the same thing. Sure, we've noticed virtual private networks (VPNs), but the benefits of it are mainly enjoyed by network administrators. Server virtualization has changed this, because most of us in the IT profession can relate to a server or machine, not to mention the very real economic benefits that companies are realizing from using server virtualization related to infrastructure-consolidation efforts or management techniques.

What we're witnessing here is an exposure and utilization of virtualization at higher and higher levels in the IT infrastructure stack. Virtualization of IT resources is like an onion. At the middle are things such as virtual memory or virtual I/O. Each successive layer of the onion uses and enjoys the benefits of the virtualization layer underneath it.

This includes the notion of virtualization as applied to applications, or *application virtualization*. Application virtualization, at its simplest level, is just removing any dependency of an application from the underlying physical architecture. The Java™ Virtual Machine (JVM) and the Python Virtual Machine are good examples of application virtual machines.² They are at a higher level, conceptually, than server virtualization, because applications run on servers (or machines). Application virtualization can extend, or complement, server virtualization.

However, application virtualization does not require server virtualization technologies to be used. There might be a variety of reasons an organization is not using or planning to use server virtualization. Organizations can gain significant benefits utilizing the capabilities of application virtualization without using server virtualization.

The application perspective

What's important to consider here, and the point of this paper, is an application perspective to virtualization. Data centers exist to run applications and services, which are part of a business process, a business imperative or a business requirement. Service level agreements (SLAs) exist because of application or service requirements. So, it makes sense to rationalize virtualization from the perspective of your application and service needs, and their requirements. This includes both SLAs and capacity requirements.



Application infrastructure virtualization provides the ability to separate applications from the physical infrastructure they run on. Workloads can then be dynamically placed and migrated across a pool of application server resources, allowing the infrastructure to dynamically adapt and respond to business needs, and allowing requests to be prioritized and intelligently routed to respond to the most critical applications and users.

Application infrastructure virtualization frees the enterprise from a tight coupling between an application and associated application servers. This loose coupling enables open standards-based software to intelligently manage and shift workloads according to agreed-upon business policy. For instance, high-priority applications can be allocated the majority of resources; lower priority applications are either designed to run later or moved to less capable resources. These operations are all seamless to the user.

Consider the following important questions:

- *How do you tie virtual machines, their configuration, their location and their life cycles to what applications and services require?*
- *How do you know if you have consolidated too much and begin to affect service and application performance, and contention?²³*

In short, do not underestimate or forget the importance of application considerations in your virtualization efforts. Ultimately, although economic benefits are gratifying, if they come at a cost of missing SLAs or not realizing the strategic business benefits from a responsive IT infrastructure, they are shortsighted.

Application infrastructure virtualization incorporates not only the ability for an application to run anywhere (core application virtualization), but additional concepts, such as application policy, policy-driven workload management and, for example, the notion of driving server virtualization from the perspective of application and service needs. Although virtualization represents a basic concept and, as we've seen, applies to many things in the IT world, how it is used and what is done with it provides the business value. This is true of server virtualization as well.

Although a virtual machine (server) provides the needed abstraction of hardware resources, it's the associated management (for example, adding CPU horsepower to a virtual machine) and quality of service (QoS) capabilities that users take advantage of. It's not the virtual machine in itself that provides the value, but the usage scenarios. As a result, it's hard to separate the notion of management and quality of service capabilities from virtualization. They are closely intertwined.

WebSphere Virtual Enterprise provides application infrastructure virtualization capabilities that lower operational and energy costs to create, run and manage your enterprise applications and service oriented architecture (SOA) environment. It works not only with IBM WebSphere Application Server, but with a wide range of application servers, such as BEA WebLogic Server, JBoss and Apache Tomcat, and can be instrumented to work with any application server capable of receiving HTTP requests.

We'll describe WebSphere Virtual Enterprise further and its value from the context of application infrastructure virtualization in more detail. We'll examine the similarities and differences between application infrastructure virtualization and server virtualization, how application infrastructure virtualization extends and complements server virtualization, and why an application-driven approach to virtualization makes sense.

Application infrastructure virtualization

Application infrastructure virtualization complements server, storage and network virtualization. It is a fourth category of virtualization in the data center (see Figure 1) that can enable your business to push the boundaries of its IT infrastructure further for greater agility, cost savings, operational efficiency, economy and manageability.

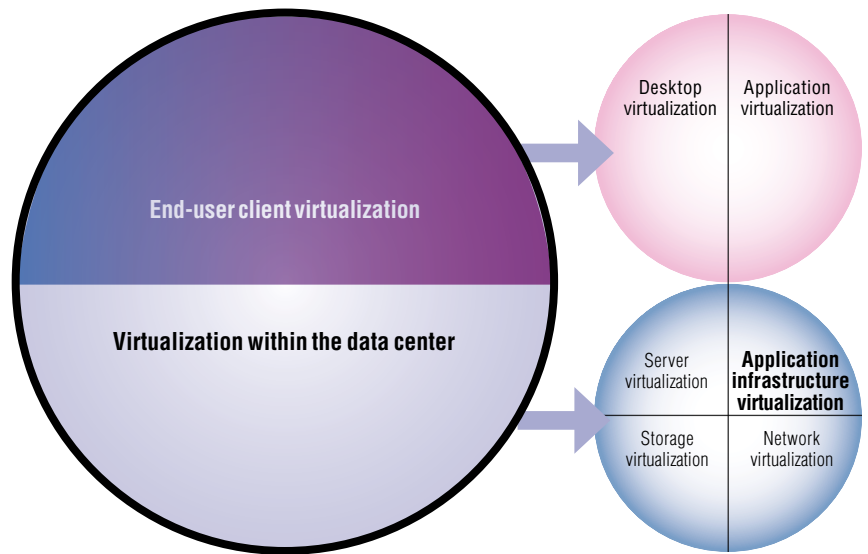


Figure 1. A comprehensive view of virtualization

Application infrastructure virtualization enables chief information officers (CIOs) and IT administrators to do more with less – literally. It allows data centers to run applications on any application server in a common resource pool. Furthermore, administrators can deploy and utilize resources quickly and seamlessly during peak periods and in response to the peaks and valleys of unforeseen demand in processing for various mission-critical applications. Last, but certainly not least, administrators can achieve application response times and service levels that meet service level agreements.

IBM WebSphere Virtual Enterprise can help your business extend the benefits of server virtualization using an approach that can address potential issues and limitations. WebSphere Virtual Enterprise can be thought of as a *hypervisor for application servers*. In addition, it enables server virtualization and application infrastructure virtualization to be combined so that you can take full advantage of the strengths of both approaches. (See Table 1 for a high-level overview of the capabilities of WebSphere Virtual Enterprise.)

Capability	Value proposition
Consolidation and optimization	Meet application response times and service levels on a minimal or optimal number of servers. This helps to optimize capital expenditure (Capex) and operational expenditure (Opex).
Flexible deployment of applications and services	Quickly provision or utilize capacity for new applications or services, or to meet increased demand.
Policy-based workload management	Manage workload and use pools of resources to achieve application response times according to policy.
Health management	Ensure application availability and application-infrastructure resiliency.
Operational management	Understand how applications are running, how the WebSphere Virtual Enterprise system is functioning and control it. Deploy applications, services and infrastructure software.

Table 1. The high-level capabilities and value propositions of WebSphere Virtual Enterprise

Similarities and differences with server virtualization

Server virtualization is becoming an increasingly important element in the IT data center. This has been primarily driven by economics and the effective use of server virtualization to consolidate multiple servers onto fewer larger servers, or to better use existing server resources. The results are greater management control, reduced administration costs and reduced costs associated with environmental factors such as power and cooling.

Servers have multiplied rapidly over the last decade, and with floor space in data centers at a premium, rapidly increasing costs for power, a move to environmental friendliness and ever-present administration costs, server virtualization has been a vehicle for consolidation. The idea is a simple one: turn physical machines into virtual ones (or realize new machines on existing hardware as virtual ones), remove the physical machines and host the virtual ones on a smaller number of servers. In fact, in its May 2007 IT spending research report, Goldman Sachs listed server consolidation and server virtualization as the first and third spending priorities for the “next 12 months.”⁴

However, server virtualization is beginning to move beyond its primary use as a vehicle for consolidation. IDC, in its 2006 *Virtualization 2.0: The next phase in customer adoption* report, forecasted a growing usage of server virtualization for business-critical high availability (HA), utility computing and workload balancing through 2010 (see Figure 2)⁵. Organizations are finding that the ability to quickly provision a machine from a template, move a virtual machine (VM) from one physical machine to another one and dynamically provide a virtual machine with additional resources opens up new possibilities for server virtualization as a foundational element of a dynamic, flexible and responsive IT infrastructure.

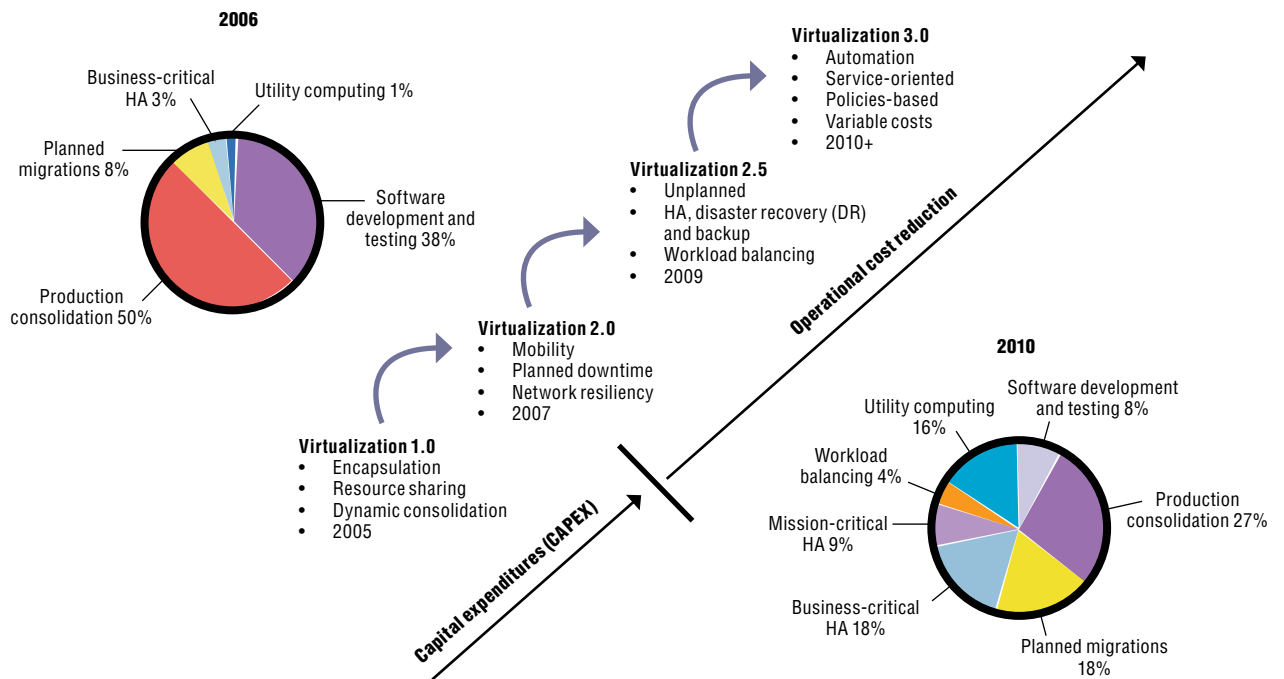


Figure 2. The use of server virtualization is growing.

Let's look at some of the specific benefits of server virtualization and, in turn, the analogous benefit for application infrastructure virtualization as realized in WebSphere Virtual Enterprise.

Quick provisioning

- **Server virtualization**

When users or departments want a machine, they no longer have to go through a lengthy purchase and deployment cycle. IT can provision a new (virtual) machine in hours instead of weeks. This is especially important to improving the responsiveness of IT service management.

- **Application infrastructure virtualization**

The main benefit here comes from the fact that in a shared infrastructure, multiple application servers are typically capable of running an application or service (as is often true for Web applications) and therefore, assuming enough capacity, applications are available for real-time processing. WebSphere Virtual Enterprise is not a "bare-metal" provisioning engine in that it does not install operating systems or middleware but does deploy applications and services, and can seamlessly work with many application provisioning technologies, such as IBM Tivoli® Provisioning Manager.



Key take-away: Moving a virtual machine around is helpful for server maintenance, but in an environment in which applications are virtualized, moving the virtual machine might not be necessary, because any machine can process the workload or application.

Mobility

- **Server virtualization**

A virtual machine can be mobile, that is, it can move from one physical machine to another. In the simplest case, this helps physical servers to be upgraded or maintained. In a more advanced situation, virtual machines can be moved dynamically, based on business-capacity needs. VMware VMotion is a good example of this.

- **Application infrastructure virtualization**

The underlying virtualization construct of the application server (JVM, for example) helps to ensure that applications are portable in that any application server in a shared application-server cluster or grid can process any request. Applications themselves aren't portable in the true sense of being frozen in process and unpacked on another application server, because if context and appropriate state can be shared (session replication), there is no need to do so. WebSphere Virtual Enterprise, however, does have a server maintenance mode, which allows servers to be taken offline and placed in maintenance mode.



Key take-away: Physical machine consolidation can be achieved using either server or application infrastructure virtualization. Combining both can lead to even further consolidation improvements.

Consolidation

- Server virtualization

As we highlighted, server virtualization is an effective way to realize efficiencies by consolidating servers. This benefit comes from either of these two methods:

- *Creating and using additional virtual machines on an existing server*
- *Turning existing physical machines into virtual machines and hosting them on a reduced set of servers*

- Application infrastructure virtualization

Policy-based workload management is a method of managing application performance and QoS according to application SLAs. A key benefit of policy-based workload management is better utilization of existing server resources. In WebSphere Virtual Enterprise, this can be achieved by either setting policies and using dynamic clusters to increase utilization of an application server on a physical server, or physically consolidating application servers on fewer physical servers, or by both in tandem, which is a unique benefit of an application-oriented approach to virtualization. The same economic benefits of server virtualization can be realized using application infrastructure virtualization and, for existing application server users, it can often be an easier approach than introducing (server) virtual machines into the production infrastructure.

Isolation

- Server virtualization

This is the view of a virtual machine as a container. Applications and processes in one virtual machine do not affect another. They are independent. This is particularly useful for a hosting environment that provides utility computing for multiple clients; in this situation, clean separation of data access is required. It is also useful when upgrades to an application residing in one virtual machine must be independent of upgrades to the same application running in another virtual machine. This is valuable to ISVs, who often have to deal with multiple levels and versions of their software.



Key take-away: Isolation is a valuable characteristic to improve system availability and resiliency. Both server and application infrastructure virtualization offer unique capabilities, and combining these two types of virtualization can be powerful.

- **Application infrastructure virtualization**

Application isolation is an inherent capability of a JVM and an application server. It's a simple concept. If an application fails and corrupts the runtime environment, other runtime environments are not affected. However, it is possible that any application server or JVM, just like any other software, can corrupt its operating environment. If server virtualization is used in conjunction with application virtualization, there is an additional level of virtualization between the physical machine and the application server or JVM, and the simple solution here is to start another virtual machine. Further, policy-based workload management can manage resource usage and allocation within the operating environment to prevent runaway applications from consuming machine resources. Later in this paper, we'll discuss the powerful effect of using virtual-machine isolation and application isolation together to increase the benefits of virtualization.



Key take-away: Flexibility is key. Avoid using virtualization to implicitly silo your infrastructure into being able to run only certain types of workloads or applications.

Ability to run multiple types of applications

- **Server virtualization**

This builds on the view of the virtual machine as a container. With virtual machines becoming the new machine, it's important that they are able to run multiples types of applications, just like a normal operating system does. This is inherently true of server virtualization. At the coarse machine level, there is utility (and flexibility) in ensuring that the container be able to run multiple types of applications and, further, ensuring that the virtual machines are not limited to running only a single application.

- **Application infrastructure virtualization**

Typically, software virtual machines such as Python VM or JVM can run only applications developed in a specific language. However, technologies such as Microsoft® Common Language Runtime support a broader range of application types. At the application level, though, there can be many types of software virtual machines that can run in a given operating environment, and the narrower scope of application support of any software virtual machine can be mitigated by employing multiple software virtual machines.

What's interesting to note here is that the main value propositions and benefits of server virtualization and application infrastructure virtualization are very similar, but the approaches are different. This is summarized in Table 2.

	Server virtualization	Application infrastructure virtualization with IBM WebSphere Virtual Enterprise
Scope	<ul style="list-style-type: none"> • OS image (coarse) • Resource-focused 	<ul style="list-style-type: none"> • Application (fine) • Application- and resource-focused
Consolidation	Vertically stacked OS images	<ul style="list-style-type: none"> • Vertically stacked virtual machines • Policy-based workload management
Optimization	Resource usage (for example, CPU) in virtual machines	Application SLAs
High availability	Restart VM instances on alternate hosts when a host failure is detected	Ensure that a minimum number of dynamic cluster instances are always running
Reliability	Cluster monitoring with visual alerts, determined by HA and capacity, and manual operator intervention	Health monitoring of application servers with automatic correction or rerouting
Admission control	Check the capacity requirements of the VM against the available capacity of the pool	<ul style="list-style-type: none"> • Manage workload traffic • Ensure that the node has capacity to run the application server

Table 2. Comparison of the technical capabilities of server virtualization and application infrastructure virtualization

Server virtualization limitations

There are, however, some potential issues and limitations associated with server virtualization. Some of these are real and some of these have a degree of perception associated with them. Let’s explore them and understand if application infrastructure virtualization can help mitigate them.



Key take-away: Use automation to control the provisioning of virtual machines. Not doing so will contribute to virtual-machine sprawl and increased management costs.

It’s too easy to provision a machine

As a result, the total number of physical and virtual machines is going to increase, and administration costs will rise further. This is a very real concern. The answer here, of course, is management control, which can be achieved if an IT organization or infrastructure software such as WebSphere Virtual Enterprise is in control of creating new *machines* as opposed to individual users or departments sharing control.



Key take-away: Consider the utilization of your virtual machines to be just as important of a concern as the utilization of your real (physical) machines.

OS licensing costs will increase

Potentially, but consider that most organizations are using server virtualization to increase utilization of existing resources or to consolidate server resources, and one can easily conclude that because of this, OS licensing costs will actually go down. In any case, with effective management control and discipline, the situation shouldn’t be any more acute than it is today or be a consequence of normal growth. Further, policy-based workload management, for example with WebSphere Virtual Enterprise, can be used to *increase* utilization of individual virtual machines, which can decrease the need for additional virtual machines and OS licenses.



Key take-away: Certain classes of applications are sensitive to the overhead associated with virtualization. Web applications are typically not one of them.



Key take-away: Fully consider the application perspective in your virtualization efforts, and drive virtualization usage and management from your application and business requirements (often referred to as policies).

The performance of applications suffers when running within a virtual machine

This is true for certain types of applications, particularly those that are I/O intensive, and to some degree there will always be some performance overhead associated with the use of virtualization. The interesting question is whether it is significant. For Web applications that are Java-based, the overhead has not proven to be significant.

Server virtualization is very coarse grained, and there is no notion of application awareness

This is a very real issue with server virtualization, hypervisors and virtual machines. Management (of artifacts) is at a very coarse-grained level (the OS or machine), so knowing when to provision additional machines, when to possibly move a virtual machine or how to perform other dynamic management capabilities lacks an application context. What is required here is the ability to peer into the virtual machine to understand the applications running in it and, importantly, their requirements. This is the essence of application infrastructure virtualization.

Extending and complementing server virtualization

There are a number of ways that application infrastructure virtualization can extend the benefits that organizations are realizing from the use of server virtualization. As we mentioned previously, some organizations find that employing only application infrastructure virtualization suffices for achieving their economic and dynamic-management goals. However, there is great utility in applying both server and application infrastructure virtualization, and leveraging the strengths of each approach. Let's take a look at how application infrastructure virtualization can extend, or complement, server virtualization from the perspective of WebSphere Virtual Enterprise.

Better isolation characteristics and resiliency

Although server virtualization is great for isolating applications and their possible ill effects from applications running in other virtual machines, it cannot prevent applications that are running in a virtual machine from affecting other applications running in the same virtual machine, or from consuming all the resources allocated to that virtual machine. This is where the policy-based workload-management and health-management capabilities of WebSphere Virtual Enterprise can help. By using application policies to manage workload, it can help ensure that an application running inside a virtual machine does not consume all the resources of that virtual machine and, therefore, affect other applications inside the virtual machine.

Further, many times virtual machines on a physical machine are configured in such a way that the total memory of the physical machine can be overcommitted. WebSphere Virtual Enterprise can work in conjunction with server virtualization to prevent this. In addition, the health-management capabilities of WebSphere Virtual Enterprise can quickly identify a problematic application or application server, attempt to fix it with either predefined or customized actions, or inform the on demand router (ODR) to route work elsewhere. This is especially valuable to help ensure a resilient infrastructure.

Increased consolidation and management efficiencies

Certainly server virtualization has proven to be very useful as a consolidation vehicle. It's a great first step. But when you combine it with the policy-based workload management of WebSphere Virtual Enterprise, you can take optimization and consolidation further by potentially reducing the number of virtual machines required. WebSphere Virtual Enterprise does this by increasing utilization of *individual* virtual machines, thus reducing the overhead of managing and administering more virtual machines than required. It's a way of mitigating the very real issue of virtual machine sprawl, and it's something that's not often considered. Sure, consolidation through server virtualization is powerful, but there is definitely a need to focus on improving the utilization of virtual machines.

Putting it all together: Application infrastructure virtualization with WebSphere Virtual Enterprise

As virtualization continues to mature, there is a need to consider the most critical resources in an enterprise: the applications and services that are the backbone of an organization's business transactions and processes. When considering the use of virtualization in an IT infrastructure, it is paramount to consider the effect on application and services. This is often a manual, trial-and-error process. Ideally, the needs of applications and services should drive all virtualization constructs and their usage, life cycles and management across an infrastructure.

WebSphere Virtual Enterprise provides application infrastructure virtualization capabilities that lower operational and energy costs to create, run and manage your enterprise applications and SOA environment. It increases flexibility and agility to help ensure business process integrity, improve service and application performance, and better manage application health.

Employing sophisticated traffic management techniques, featuring integrated health management capabilities and policy-based workload management, WebSphere Virtual Enterprise takes an application-centric approach to virtualization. It can be thought of as a *hypervisor for application servers* and can extend the value that organizations are realizing from server virtualization, particularly in the areas of increased resiliency, flexibility and the economic advantages associated with infrastructure consolidation.

Quantifying the benefits of WebSphere Virtual Enterprise

WebSphere Virtual Enterprise can help provide tangible cost savings as well as QoS benefits. IBM has created a total cost of ownership (TCO) tool, known as the WebSphere Virtual Enterprise Value Assessment.

WebSphere Virtual Enterprise Value Assessment is designed to quantify not only the technological benefits of deploying WebSphere Virtual Enterprise within an organization but also the financial benefits. The organization's TCO data is captured in a multiyear cost model that compares the current application server environment with that of the envisioned WebSphere Virtual Enterprise technology-enabled environment. The cost data includes IT expenses related to both implementation and operations.

WebSphere Virtual Enterprise Value Assessment is a process that comprises the following five steps:

- *The organization's objectives and scope are verified and clarified before data collection begins.*
- *Data is collected against the organization's current server environment.*
- *Data is validated and examined to search and refine potential benefits.*
- *The organization's investment costs are identified and captured for reference.*
- *A TCO model is assembled, and a business case is developed.*

After the assessment is complete, the organization receives a copy of the customer-specific TCO model, presentation of the business case for WebSphere Virtual Enterprise deployment, and the solution architecture for transforming the organization's existing infrastructure into an application infrastructure virtualization environment.

Based on a number of WebSphere Virtual Enterprise Value Assessments done with leading organizations, the energy and cost savings using WebSphere Virtual Enterprise can be substantial. Here are the areas where savings can be expected over a multiyear period:

- *Hardware cost savings of 25 percent to 40 percent⁶*
- *Energy cost savings of 25 percent to 40 percent⁷*
- *Administrative operational cost savings of 35 percent to 55 percent⁸*
- *Planned maintenance cost savings of 45 percent to 55 percent⁹*
- *Reduction in unplanned outages of up to 98 percent and achieving 99.999-percent uptime¹⁰*

For more information

To learn more about WebSphere Virtual Enterprise and application infrastructure virtualization, contact your IBM representative. Ask the representative to conduct a WebSphere Virtual Enterprise Value Assessment to gain a better understanding of your application server environment along with the financial and operational performance benefits that could result from using WebSphere Virtual Enterprise. The assessment can enable you to develop a business case for deploying WebSphere Virtual Enterprise that's tuned to your business priorities and growth plans to support project funding and budgeting. In addition, ask your sales representative to schedule a WebSphere Virtual Enterprise proof of technology (PoT) demonstration.

For more information, visit:

WebSphere Virtual Enterprise

ibm.com/software/webservers/appserv/extend/virtualenterprise/

Article: *Application infrastructure virtualization takes businesses further than many thought possible*

ibm.com/systems/virtualization/view/020508.html



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- ⁵ "Virtualization 2.0: The next phase in customer adoption," Docu #204904, IDC. 2006.
- ⁶ Hardware cost savings due to server consolidation with target utilization ranges from 40 percent to 60 percent.
- ⁷ Energy cost savings linked to the hardware cost savings. Savings range could vary based on dollars per kilowatt hour (kwh). Additionally, the energy savings would depend on various factors, including the specific server power consumption ratings and the varying kwh costs by geography.
- ⁸ Administrative savings can vary greatly depending on how an organization wants to view administration full time equivalent (FTE)-related reductions (such as workforce reduction versus repurposing versus cost avoidance of future hire).
- ⁹ Planned maintenance cost savings derived using planned outages and maintenance estimated at 8hrs/qtr/server = 32 hrs/year/server. Calculation uses 75 percent of server pool and a conservative cost savings benefit at 50 percent of using WebSphere Virtual Enterprise.
- ¹⁰ When using the average availability for the "as-is" (99.95 percent) contrasted with using WebSphere Virtual Enterprise at five-9s (99.999-percent uptime). This translates to going from 263 minutes of unplanned outages annually to 5 minutes annually.