



Virtualizing Business-Critical Applications: Oracle Database

TECHNICAL WHITE PAPER

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“Business-critical applications provide competitive advantage. The real risk for companies is missing the opportunity to innovate with IT and drive toward business agility.”

— CIO Magazine/IDG report, December 2011

Virtualization continues to define the modern architecture of enterprise IT, establishing both a new model for how applications are run and a path to cloud computing. Still, some organizations are hesitant about migrating business-critical applications such as Oracle Database to a virtual environment.

In this white paper we examine the current state of business-critical application virtualization, particularly of Oracle Database: How pervasive is it? What is the market saying about the pace—and the wisdom—of this evolution? We discuss how the latest software and hardware advances have shifted the thinking about virtualization, and offer examples of organizations that have successfully taken this important step. Last, we present partners that can ensure a successful Oracle Database migration, and discuss ways to optimize your newly virtualized environment.

Virtualization Journey

You know it better than anyone: software is increasingly being operated in a virtual world.

Consider these findings:

- At the close of 2011, estimates from VMware and independent market analysis indicated that customers had virtualized, on average, more than 40 percent of their workloads.
- These same studies estimated that customers would increase the share of workloads by approximately 10 percentage points annually.
- More than two-thirds of all server workloads will be running on virtual machines by 2014.
- Separate studies show that, beginning in 2010, there were more virtual servers deployed by enterprises globally than physical servers—indicating that customers had shifted to a “virtualization first” philosophy.
- The number of virtual machines used in the market for server workloads will grow by a factor of five between 2010 and 2015.

Clearly, virtualization is enabling many organizations around the globe to improve manageability, increase speed and agility, and shed costs—and all while serving as the clear foundation for cloud computing. Yet, despite this seismic shift, some have yet to migrate their most critical applications to a virtual environment. The reasons vary. Business-critical applications are frequently governed by a complex set of internal teams with different goals, and these teams are sometimes hesitant to risk the availability of core applications.

Why Virtualize Business-Critical Applications?

Business-critical applications are at the heart of an organization; their performance, availability and reliability are vital to the success of the business. As a result, organizations are often especially cautious about changing the platform for applications that are core to the business’s revenue generation or operational performance.

Yet, the IT status quo, with its silos of application environments and spiraling operations costs, is becoming unsustainable. According to research firm Forrester, companies are now spending 70 percent of IT budgets on application maintenance and updates — a situation that is certain to change soon, given the premium placed today on reducing IT expenditures.

Other research reflects this dynamic. In January 2012, IDC predicted a new phase of virtualization adoption, beginning this year, along with new and significantly different drivers—server consolidation chief among them. This trend represents the market as a whole; the most forward-thinking of organizations are well ahead of this curve.

Moreover, an IDG Research study published by the CIO Custom Solutions Group in late 2011 demonstrated that virtualization of business-critical applications has become a mainstream trend across the market. IDG surveyed 300 corporate decision makers at enterprises around the world, exploring the experiences of enterprises that have

Full Support from Oracle

Oracle fully supports the virtualization of Oracle databases on VMware, including support for Oracle Real Application Clusters (RAC). To augment this support, VMware has a total ownership policy for customers with Oracle issues and will be accountable or any Oracle-related issue reported by our customers.

virtualized business-critical applications—packaged and custom—and determining which benefits these companies have realized as a result. IDG's findings included these points:

- There is overwhelming support among business and IT leaders for taking business-critical applications to the next level, in preparation for the cloud era.
- Enterprises that have virtualized their critical applications are getting excellent results:
 - 60 percent reported improved quality of service—including increased efficiency, improved business continuity and less downtime.
 - 60 percent reported reduced total cost of ownership.
- 78 percent agreed that when critical applications were virtualized, their IT teams became more agile; 75 percent agreed that their overall business has become more agile.

Why Virtualize Oracle Database?

We've discussed the current thinking about virtualizing business-critical applications in general. Let's turn now to the central question: Why virtualize Oracle Database? And perhaps just as important: Why now? Have the facts changed?

In a word: yes. First, we'll examine how the evolution of hardware and VMware vSphere® 5.0 has rewritten the virtualization equation. Then we'll present the key reasons to virtualize Oracle Database, accompanied by real-world success stories about how and why other organizations have done so.

Latest Hardware Exceeds Requirements

Significant advances in hardware—such as dual- and quad-core processors, higher memory density, and advances in storage technology—are far outpacing the performance requirements of even the most intensive business-critical applications, including Oracle Database. This is especially true when those applications are virtualized and hardware resources are being utilized at an optimal level.

Performance Increase with vSphere 5.0

VMware has kept pace with these hardware improvements by engineering significant performance advances in vSphere. vSphere 5.0 provides two to four times the performance of the previous-generation platform, with 32 vCPUs and 1TB of memory per virtual machine and more than 1,000,000 disk IOPS, while keeping virtualization overhead to a minimum. With these performance improvements, vSphere is able to run very large, resource-intensive databases and, in many cases, enable applications to scale better on newer multicore servers.

Specifically, deploying Oracle databases on vSphere 5.0 provides the following performance benefits:

- **Near-native performance** – With minimal virtualization overhead, Oracle databases run at performance and service levels similar to those of a physical system.
- **Extreme database I/O scalability** – The VMware ESX® thin hypervisor layer can drive more than 60,000 database I/Os per second—50 times the requirement of a typical database.
- **Multicore scaling** – Organizations can scale up using virtual machines and multiple database instances.
- **Large memory** – Memory can be scaled up to 64GB per database, 255GB per host.

Compelling Reasons to Virtualize Oracle Database

Taken together, these factors mean that a virtualized Oracle Database environment results in powerful benefits.

Better availability – In an increasingly demanding business world, virtualization holds enormous advantages over physical infrastructures with regard to availability. Virtual machines that reside on the same physical server share underlying hardware resources but are completely isolated from each other—as if they were physically separated. This means that if one virtual machine experiences availability problems, it does not affect the availability of applications running on other virtual machines on the server. And if the underlying hardware itself experiences performance or availability problems, live applications can migrate automatically from one physical server to another—with no interruption in service.

Although application - level clustering has been the prevalent solution for most Oracle Database implementations, virtualization with the vSphere platform can enhance the overall availability of Oracle Database by providing options that help limit both planned and unplanned downtime. In fact, the features provided by vSphere 5.0 will satisfy the availability requirements of most organizations, eliminating the need to follow traditional clustering approaches. For other organizations that require a greater degree of availability, application-level clustering can be combined with VMware vSphere High Availability features to create an extremely flexible environment, with options for failover and recovery at both the hardware and application levels.

Higher quality of service – A major challenge facing Oracle Database owners today is the ability to maintain service levels. Service-level agreement (SLA) issues include drops in performance due to unplanned growth, and applications that do not scale in any direction quickly, much less dynamically. Virtualization addresses these challenges: performance and capacity can be managed in a far more proactive and predictive manner, and applications can easily be scaled on demand to meet changing throughput requirements.

Faster time to market – Delays in bringing new applications to market can result in significantly higher deployment costs, as well as lost revenue. Virtualization increases the speed and agility with which you can test and deploy, and with automated provisioning, reduces time to market from the usual period of months to a matter of hours.

Server consolidation and lower costs – Databases are among the most overprovisioned applications in the datacenter, creating a tremendous opportunity for consolidation. With virtualization, the Oracle Database infrastructure can typically be consolidated by a factor of 5 to 10 compared with a physical environment. And by reducing the amount of hardware required to run your Oracle Database environment, you can save money not only on the hardware itself and on the related power, cooling and management costs, but also on corresponding database licenses.

Forrester Study Highlights the Benefits of Virtualizing

In 2011, VMware commissioned Forrester Consulting¹ to examine the total economic impact and potential return on investment (ROI) that enterprises can realize by virtualizing mission-critical Oracle databases on the vSphere platform. Forrester interviewed four VMware customers, including

- A global Fortune 500 manufacturing firm with more than 8,000 end users and two datacenters
- A large medical and scientific testing facility with 28,000 employees, serving 220,000 clients and a range of operating units
- An educational institution with more than 100,000 students, faculty and administrative employees, along with 200 research centers and institutions
- A large educational institution outside the United States with 54,000 students

The interviews uncovered the following relevant points:

- Most customers interviewed stated that they virtualized their Oracle databases to reduce hardware failure.
- Customers virtualized their Oracle databases only after gaining significant experience with and achieving benefits from the virtualization of other applications on vSphere—primarily back-office applications.
- A director of IT at one of the interviewed companies said his organization had begun virtualizing its mission-critical Oracle databases on vSphere a few years ago. While the organization has increased the total number of Oracle databases by virtualizing hardware, it has seen a reduction in the time that database administrators (DBAs) spend on support by 50 percent. Other benefits included
 - Freeing up DBAs to work on higher-value-add activities
 - Speeding time to market with new services and features
 - Improving end-user productivity through less-frequent planned and unplanned downtime
- Customers interviewed said they achieved virtualization ratios of 7:1 to 15:1 virtual machines per physical host with their Oracle databases.

Critical Advantages for DBAs

Clearly, virtualization of Oracle databases offers the powerful benefits of increased organizational agility, productivity and cost control for top executives such as CIOs, CFOs and CEOs. But what about database administrators (DBAs)—the people who actually work with these business-critical databases every day, and who shoulder the direct responsibility for their peak performance?

DBAs are constantly challenged to provide 24/7 database services to application owners with the flexibility and autonomy they expect, while keeping the infrastructure as simple and economical as possible. A common issue is that traditional databases running on fixed physical hardware are often oversized, underutilized and protected by complex, expensive clustering solutions, and they require rigorous processes for version control and continued application compatibility.

A critical factor for DBAs is that VMware virtualization creates a layer of abstraction between the resources required by an application and the operating system (OS), and the underlying hardware that provides those resources. By decoupling the OS and the Oracle Database applications from the hardware, vSphere enables virtualized databases to react dynamically to changes in underlying system resources such as CPU, memory, storage and network.

This decoupling also addresses many difficult design problems for DBAs regarding scalability, high availability and resource isolation that exist in the traditional, physical environment. With virtualization, migrating to new hardware is far simpler, faster and less costly. DBAs can migrate databases from physical to virtual environments—or from one box to another—in their current state without expensive and error-prone application migrations. Plus, there is a great reduction in complexity. Once DBAs are operating inside vSphere, they can avoid a range of issues that were previously caused by a lack of standardization.

vFabric Data Director: Data Management Tools for Your Cloud

Another advantage to virtualizing Oracle databases—for DBAs and CIOs alike—is the ability to utilize the capabilities delivered by VMware vFabric™ Data Director. Installed on top of vSphere 5.0 Enterprise Edition™ or Enterprise Plus Edition™, vFabric Data Director enables organizations to implement database-aware virtualization on vSphere, combining the convenience of public cloud database services with the enterprise-grade security, flexibility, control and compliance of your own private and hybrid clouds.

vFabric Data Director supports Oracle 10gR2 and 11gR2 and provides three distinct sets of capabilities:

- **Database-aware virtualization** – Virtualizing databases requires a series of steps, and DBAs need to be familiar with the virtual infrastructure and operations. vFabric Data Director simplifies this process by providing a unified platform with integrated capabilities—enabling DBAs to easily virtualize databases on the proven vSphere infrastructure using built-in workflows. It also helps DBAs to maintain security, data protection policies, resource consumption, and database configuration best practices.
- **Automated life-cycle management** – vFabric Data Director helps DBAs automate time-consuming database life-cycle management tasks and provide better SLAs to the business. Now, DBAs can maintain consistent policy enforcement with automated resource, high availability and backup policies for all databases, and developers can easily create, self-service-provision, clone, snapshot and back up databases.
- **Self-service** – Database as a service becomes a reality with vFabric Data Director—empowering diverse database applications such as self-service database provisioning and self-service database management, governed by DBA-defined policies and robust role-based access control (RBAC). Developers can spend more time coding, and DBAs can focus on business-critical functions.

Real-World Successes: Vermont Utility Company Virtualizes Its Oracle Databases—and Avoided Disaster

Green Mountain Power is Vermont's largest utility company, with over 100,000 customers. As part of its Smart Grid Initiative, it recently moved its Oracle applications, including all of its Oracle databases, onto VMware vSphere. Using the Oracle Application Testing Suite, it performed extensive testing on each of the applications and has experienced high performance throughout the testing.

The change came at a good time. When Hurricane Irene swept through the Northeast in 2011, it knocked out power to nearly 50,000 of Green Mountain Power's customers—yet the newly virtualized environment was quickly back up, recovering far faster than a physical environment.

"Our systems were up and running, and our users were happy. Performance was great. People in our districts were getting the resources from our systems that they needed."

— Paula Fortin, Systems Administrator, Green Mountain Power

When to Deploy?

For many organizations considering virtualizing their Oracle databases, the question of “if” is closely tied to the question of “when.” Although each company is different, certain triggers create opportunities for virtualizing Oracle Database:

- **Hardware refreshes** – If you’re looking into purchasing new hardware—because your existing hardware is coming off lease or its maintenance is finished—this is also a good time to look into virtualization. Deploying virtualization on the latest chipset greatly enhances performance.
- **Data platform changes** – Virtualization is becoming a high-profile item on the agenda of CIOs examining how to reduce the cost of their database architecture across their applications.
- **Database migration** – This is a major technology change and most likely involves a change in hardware. It makes sense to further reduce your operating costs, not just the capital expenditures, by changing your database and virtualizing at the same time.
- **New Oracle Database installations** – In hindsight, deploying a new landscape or a new module on physical hardware might be viewed as a missed opportunity. Your implementation can proceed much more quickly when you don’t have to deal with physical servers.
- **Upgrades** – Virtualizing is a perfect way to help speed up Oracle Database upgrade projects. You can reduce the costs in the rollouts by virtualizing those projects immediately and then putting disaster-recovery technology around them.
- **Disaster recovery** – Many companies still use tape or disks (or both) as their backup for catastrophic failures. Having a virtualization solution in place for disaster recovery is a major step in automation.

Real-World Successes: Large Distributor Achieves Dynamic Scaling of Oracle RAC

American Tire Distributors (ATD) of Huntersville, North Carolina, is the nation’s largest replacement tire distributor. ATD wholesales its tires through a network of more than 85 distribution centers in 37 states, which serve an average of 80,000 customers per day.

Challenge

ATD had already embraced VMware virtualization technology within its applications tier; now, it wanted to virtualize its Oracle RAC database tier.

“To support a business that is growing 10–20 percent annually, we need to be able to scale in any direction,” notes Tony Vaden, CIO, ATD. “Either vertically, by adding CPU or memory, or horizontally, by adding applications or database capacity. And we have to be nimble and be able to scale out quickly.”

Solution

Before proceeding with virtualizing its database tier, ATD wanted to verify that its Oracle RAC cluster would perform as well under VMware as it would on a physical server infrastructure. The company engaged House of Brick Technologies, a VMware channel partner, to help it upgrade its Oracle databases from version 10g to 11g, and to provide design consultation.

House of Brick recommended that ATD implement its upgraded Oracle RAC nodes under VMware and on HP ProLiant servers, instead of staying on the more costly PA-RISC platform. It then designed a proof of concept to test whether this architecture would have a negative impact on database performance. To perform the tests, House of Brick used Oracle’s RAC load-test tool to capture 3.5 hours of ATD’s peak production load activity: 29 million transactions totaling 1.5TB of data and representing a broad cross-section of operations. It then used a proprietary import/export utility to migrate the snapshot onto two environments, one replicating the legacy PA-RISC deployment, and the other a five-node virtualized

server deployment running under Red Hat Linux on HP ProLiant servers. The VMware environment was configured with the same amount of memory used to run the nodes under PA-RISC—but with half the number of CPUs.

Using the House of Brick tool, migration was completed in 36 hours—versus the estimated 12 days if the team had used standard Oracle data-migration procedures. Once the migration was complete, the team replayed the transactions and compared the environments' performance.

The differences were striking. The performance of the x86 deployment far outstripped that of the legacy PA-RISC deployment, and the hardware in the virtualized environment never exceeded around 10 or 12 percent utilization. Within the physical server test environment, the hardware—with twice as many CPUs—needed to run at 70-100 percent utilization to accommodate the same workload.

Results

The test proved to ATD that virtualizing its Oracle RAC databases would improve the performance of its database tier. ATD is therefore moving forward on virtualizing this last piece of its infrastructure.

“We consider VMware to be an enabling technology,” concludes Vaden. “From our Exchange servers to our ERP environment, we’ve seen success stories throughout our entire footprint ever since we virtualized our first application.”

Getting Started with VMware Professional Services

So, how do you begin? Whether you're still undecided about migrating Oracle Database to a virtual environment, or you're ready to deploy, the VMware Professional Services organization is an ideal partner. Its Business-Critical Application Virtualization Services team provides the expertise and solutions needed to design your requirements for availability, performance and other parameters into the framework—before you build—reducing risk and deployment time, and increasing ROI.

Your VMware Professional Services team of experts can take you through best practices for each stage of the development cycle, from initial discussions through optimization, shown in the following list. Some organizations will want to start with the initial discovery stage; others that are further along in the development cycle might engage the Professional Services team in the assessment or planning stages.

- **Discover** – Our Virtualization Advisory Workshop is perhaps best suited for customers who are unsure whether to move forward with virtualizing Oracle Database. During the workshop, our consultants present best practices and available solutions, perform a high-level evaluation of your company's current state and requirements, and outline a virtualization road map. The workshop can be expanded to include a deeper analysis, including a review of architecture options, proposal of a solution and analysis of risk.
- **Assess** – There are two options within this service:
 - **Virtualization Accelerator Service** – This option is ideal for customers who have gained internal support for virtualizing Oracle Database—and are now ready to demonstrate feasibility to other key stakeholders. Our experts work with your team to install and test a single virtualized Oracle Database workload in a preproduction environment, providing solution validation as well as insight and knowledge related to implementing and managing a virtualized Oracle Database environment.

- **Virtualization Assessment Service** – The Business-Critical Application Virtualization Assessment Service for Oracle Database is intended for customers who need help developing a road map for their specific Oracle Database initiative, validating or defining related requirements, and defining an Oracle Database virtualization architecture framework. VMware consultants work with your team to evaluate your current environment—people, processes and technology—and help to determine your specific path to successfully designing, implementing and operating a virtual Oracle Database environment.
- **Plan and design** – This step is intended for organizations that already have well-defined requirements and executive support to virtualize Oracle Database, but lack the staffing, experience or expertise to develop detailed production-ready design specifications. Our consultants help you employ best practices to ensure successful virtualization of your Oracle Database infrastructure.
- **Build** – This service is ideal for organizations that have completed the plan and design process and would benefit from expert guidance on the implementation process. Using best practices, our virtualization experts install, configure and perform extensive system testing on the virtualized environment to support the rigorous requirements of your Oracle Database applications. They also provide production migration assistance and oversight, helping to expand your team’s knowledge while keeping the project on track.
- **Optimize** – This service is suite for customers who have virtualized Oracle Database—and want to maximize value. VMware consultants perform a full health assessment of your virtualized Oracle Database environment, analyzing and reviewing operational elements, developing a scorecard, and providing actionable recommendations to tune the virtual environment for efficiency and stability and to support future growth. VMware consultants can also provide advice and operational assistance to help increase your team’s knowledge of current best practices and bridge gaps in skills.

Throughout the process, our reliable, repeatable methodology and seasoned consultants will help reduce risk and downtime, accelerate your deployment, and ensure first-time success.

Real-World Successes: Indiana University Teams with VMware Experts to Virtualize Oracle Databases

Indiana University (IU), with eight campuses throughout Indiana, has more than 100,000 students, 18,500 employees, and 200 research centers and institutes. It is considered one of America’s most wired universities.

Challenge

With 1,000 servers—nearly 90 percent of its total—already virtualized on vSphere, IU wanted to migrate its largest databases from an IBM AIX pSeries platform to a virtualized Linux environment on vSphere. The objective: Move from a more expensive, proprietary platform to a more efficient, industry-standard x86 platform, while increasing the flexibility and agility of IU’s Oracle databases.

“We already had five-nines availability; flexibility was the prominent motivator, such as the ability to migrate databases between hosts, and to plan capacity at the datacenter level instead of on a ‘per app’ basis,” says Rob Lowden, director of IT at IU. “We also wanted to more easily migrate systems and capitalize on the other advantages of virtualization, such as cost savings.”

The big question was whether vSphere, running on Linux, could handle larger application workloads such as OnCourse, one of IU’s largest and most critical Oracle databases. OnCourse communicates and tracks assignments and class schedules for the student population, supporting approximately 125,000 users—12,000 concurrently and with heavy activity.

Solution

To test and demonstrate the feasibility of this migration, IU contracted VMware Professional Services to do a proof of concept using OnCourse as the prototype Oracle workload. VMware partner House of Brick was engaged to bring Oracle and VMware best practices to the table and assist in the analysis and tuning of the OnCourse application.

Over a six-week engagement, an OnCourse workload was captured during two of IU's busiest weeks of the year—including the first week of school. Students and teachers were using OnCourse heavily to register for courses, order books and post descriptions, among other processing-intensive tasks. System performance metrics from the existing AIX production environment were collected simultaneously. Performance data was analyzed to determine bottlenecks in the existing AIX production environment and to build a prototype virtual production environment to mitigate them.

Next, data from the captured peak workload was used to emulate the OnCourse production environment in the prototype virtual environment, and test results were recorded to determine performance gain. The results: CPU usage in the prototype virtual production environment was 50 percent of eight virtual cores, compared to 100 percent of nine physical cores in the existing physical environment.

Allowing for faster CPUs and comparing this with the user CPU time on the AIX environment, the prototype virtual production environment outperformed the Power5 processors significantly. A workload in the AIX environment captured over a 50-minute time period was replayed in the prototype virtual production environment in just 43 minutes.

Results

Virtualization has taken capacity planning at IU to a new level. The IT team can now size up and size down virtual machines to ensure service levels to comfortably handle the peak loads encountered by IU's Oracle databases. IU has also achieved greater flexibility and agility for databases with fast provisioning and virtual-machine mobility.

Using outside technical assistance was key. "When you're fine-tuning a tier 1 application to run optimally, you need both application and infrastructure expertise," says Lowden. "VMware Professional Services provided their combined expertise and helped us define success criteria." He adds, "Where initially we believed that these databases would be too demanding for a virtual machine, we now have the confidence that vSphere can handle our largest transaction-processing databases with ease."

Additional Resources

These additional services can help organizations cultivate and foster the growth of their virtualized platform:

- **VMware Technical Account Managers (TAMs)** – Available through the Professional Services organization, TAMs are cross-functional VMware experts who can help you accelerate the business value from the transition to IT-as-a-service (ITaaS) computing models, with less risk.
- **VMware Education Services** – This organization provides virtualization technical training and certification programs for your internal teams.
- **VMware Authorized Training** – This training gives you the skills and confidence to handle enterprise-level deployments of vSphere. It is available at more than 600 locations worldwide, either directly from VMware or at one of more than 200 VMware Authorized Training Centers.
- **Free online training** – VMware also offers free online classes in virtualizing Oracle Database.

- **VMware Partners** – The network of VMware service partners is an excellent resource for helping you move forward with Oracle Database virtualization. We've brought together a broad range of technology and service partners—more than 25,000 of them—and your VMware account representative can recommend specific ones to serve your needs best.

Maximizing Your Virtualized Oracle Databases

Once you've virtualized your Oracle databases, how can you fully optimize and maximize the investment? There are many options; here are two examples:

- **Business continuity and disaster recovery** – VMware vCenter™ Site Recovery Manager™ (SRM) 4.0 provides business continuity and disaster-recovery protection for virtual environments—an especially important consideration for Oracle Database. Disaster-recovery testing using physical servers can be difficult because it is usually very disruptive, expensive in terms of resources, and extremely complex. By leveraging virtualization, SRM addresses this problem, while making planning and testing simpler to execute.
- **Proactive performance management across the entire infrastructure** – Traditional tools and processes designed for fragmented, static physical infrastructures don't provide the automation and control you need to effectively manage highly virtualized and private cloud environments. VMware vCenter Operations Management Suite™ provides automated operations management using patented analytics and an integrated approach to performance, capacity and configuration management. Tightly integrated with vSphere, vCenter Operations enables IT organizations to get better visibility and actionable intelligence to proactively ensure service levels, optimum resource usage, and configuration compliance in dynamic virtual and cloud environments.

More Uptime and Efficiency; Lower Costs

In a study published in June 2012, The Aberdeen Group² examined the experiences of a diverse group of companies that had virtualized their Oracle databases. The study identified the following benefits of virtualization:

- **Greater application uptime** – Easier disaster recovery and reduced outage/downtime mean that applications are running and available more of the time to support business processes. Virtualization features such as application mobility (moving running applications from one server to another), site recovery (moving suites of applications over the WAN) and automatic resource deployments (adding memory or CPUs to stressed applications) contribute to improving application uptime.
- **Operational efficiencies** – Freeing IT from repetitive tasks, or reducing the time dedicated to those tasks, improves productivity. Freed IT resources can be assigned to more important projects, such as deployments.
- **Reduced expenses** – Eliminated costs contribute to the positive ROI of a project. These reduced expenses can take two forms: capital expenses (CapEx) and operational expenses (OpEx). Also, faster application upgrades/installations and reduced power and cooling expenses help lower the cost of supporting applications.

Conclusion and Next Steps

We are at a crucial point in the virtualization of Oracle databases. Organizations are being driven forward by a business environment that demands ever-greater agility and stability, with reduced risk and cost. This demand comes at a time when the common arguments against virtualizing Oracle databases—insufficient performance and the risk of not meeting service levels—have faded in the face of recent advances in software and hardware.

In the demanding world of Oracle application development and deployment, a virtualized infrastructure brings significant advantages to the enterprises. Now is the time to join the many VMware customers on the next step of your journey to transform your infrastructure.

Depending on where you are in the decision cycle, we encourage you to consider one of these next steps:

- **If you are considering virtualizing Oracle Database—and want to learn more:** Schedule a Virtualization Advisory Workshop. This workshop will help you understand what is required in virtualizing Oracle Database, and discusses the risks, best practices and a high-level transformation road map.
- **If you are ready to embark on Oracle Database virtualization:** Contact VMware Professional Services, and we will work with you to begin the journey.

1. Forrester Research, Inc. "Total Economic Impact of VMware vSphere Virtualizing Mission-Critical Oracle Databases." Sadaf Roshan Bellord, Project Director, August 2011.
2. Aberdeen Group. "The Case for Virtualizing Your Oracle Database Deployment." May 2012.



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