ORACLE VM

Oracle VM at Oracle

Powering a Demanding Enterprise Operation

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Introduction

Much like Oracle's customer base (some 400,000 companies in 145 countries), Oracle deploys Oracle database, middleware, and application products to support its day-to-day business operations. Oracle IT departments are chartered to provision and manage continuously available enterprise applications critical to running its business. These applications deliver strategic functionality across all facets of the company—from product development to financials to support for production, sales, and service operations, allowing more than 120,000 Oracle employees to be productive each and every day.

By virtualizing enterprise applications using Oracle VM, Oracle's IT organizations realize greater flexibility and lower infrastructure costs. Instead of implementing physical machines for each required operating system version and application release, virtualization using Oracle VM consolidates servers and provides efficiencies that help to decrease capital (CAPEX) and operating expenses (OPEX). At the same time Oracle VM helps IT deploy services more rapidly, allowing administrators to provision new applications quickly to meet emerging requirements and shifts in application demand.

Oracle relies on Oracle VM as its premier virtualization technology—and not just because Oracle VM is Oracle's own virtualization software. Based on proven Xen hypervisor technology, Oracle VM offers reliability and scalability for enterprise applications—Oracle Database, Oracle Fusion Middleware, and Oracle applications: Oracle E-Business Suite and Oracle's PeopleSoft, JD Edwards EnterpriseOne, and Siebel Customer Relationship Management (Siebel CRM). Oracle software teams aggressively test and fully integrate these applications with Oracle VM. That's why Oracle IT managers know that virtualization on Oracle VM delivers the performance and high service levels needed to meet exacting business requirements. Complementary technologies such as Oracle VM Templates accelerate application provisioning, allowing administrators to stand up complete Oracle application stacks reliably and repeatedly, reducing deployment risk and speeding time-to-use.

This paper highlights Oracle IT environments—notably Oracle Product Development IT and Oracle Managed Cloud Services—that rely on Oracle VM to deliver highly reliable Oracle enterprise applications. It discusses the advantages that these IT organizations achieve by virtualizing workloads on Oracle VM, especially for Oracle Database and Oracle software applications that demand continuous availability, scalable performance, and easy manageability. The paper also discusses how several Oracle engineered systems incorporate Oracle VM. Tight integration in these systems enhances the overall stability and scalability of Oracle application workloads on Oracle VM, both for deployments on engineered systems as well as on general-purpose servers.

Oracle VM in Oracle Product Development IT

Oracle Product Development IT (Oracle PDIT) is responsible for supplying infrastructure and applications for internal Oracle development engineering groups as well as Oracle's private and public cloud service organizations. Oracle PDIT manages thousands of systems and hundreds of petabytes of storage. The group is responsible for provisioning and managing numerous production instances of Oracle Database, Oracle Fusion Middleware, and Oracle application products.

Oracle PDIT relies almost exclusively on Oracle VM to support application workloads, deploying more than 310,000 virtual machines (this number reflects the VM count as of October 2014 and it continues to grow). The group possesses over eight years of production experience with Oracle VM software and has standardized on this technology because of its proven stability and extreme reliability, especially for Oracle application workloads.

Best Practices that Increase Service Levels

To manage such a large and varied array of Oracle applications effectively, Oracle PDIT attains efficiencies from standardizing its deployment environments and following best practices. As standard practice, Oracle PDIT deploys applications on Oracle VM Server for x86 in Oracle Linux guests running the Unbreakable Enterprise Kernel (UEK). As necessary Oracle PDIT also deploys Oracle VM Server for SPARC and Oracle Solaris, but the vast majority of VMs are built using Oracle VM Server for x86 and Oracle Linux. (Note that Oracle VM Manager can be used to control both Oracle VM Server for SPARC and Oracle VM Server for x86 virtual servers.)

By standardizing on Oracle VM and Oracle Linux, Oracle PDIT is able to reduce downtime, optimize availability, and meet rigorous service level agreements. Years ago Oracle PDIT had an availability target of 99.0 percent, but at the time had difficultly regularly meeting this goal. Administrators coped with non-standard environments (including non-virtualized servers) that resulted in an overwhelming number of incident reports. Multiple Linux OS implementations meant multiple patch configurations. It was difficult for administrators to keep servers current with the latest updates and security errata. Today the availability goal for Oracle PDIT is 99.9 percent—a target that Oracle PDIT is able to meet consistently because of its reliance on Oracle VM and Oracle Linux. Fundamental Oracle VM and Oracle Linux technologies that help Oracle PDIT successfully meet this demanding level of service include:

- Oracle Linux Ksplice. This technology allows administrators to apply an updated Linux kernel—either the Oracle Unbreakable Enterprise Kernel (UEK) or the Red Hat Compatible Kernel—without a reboot. Ksplice eliminates the need to take servers off-line when applying patches to production kernels or to implement a debugging kernel for troubleshooting.
- Oracle VM Secure Live Migration. This capability minimizes downtime that is often necessary in non-virtualized deployments. Secure Live Migration safely moves an active virtual machine from one system to another while the VM and any applications it supports continue to run.
- Oracle VM Templates. Oracle VM Templates define pre-optimized application deployments, allowing administrators to rapidly provision standardized virtual servers with fully configured solution stacks.

Oracle PDIT realizes significant advantages through the use of Oracle VM and these features.

Virtual Server Patching with Zero Downtime

Like other IT departments, Oracle PDIT implements a rolling patch cycle to apply application and operating system updates across its servers. Major version upgrades and infrastructure refresh projects occur on a 6-month schedule, while a 3-month schedule is used for rolling patch updates. Security patches are applied on a more immediate basis to minimize the risk of exposing mission-critical systems to unplanned downtime. When applying kernel updates or security patches to Oracle Linux servers running on Oracle VM, Oracle PDIT takes advantage of Ksplice technology to avoid downtime. Ksplice applies updates to actively running Linux kernels, allowing administrators to update servers running production workloads without a reboot. This capability eliminates downtime, allowing Oracle operations to continue without interruption and encouraging greater productivity.

Secure Live Migration

Like Ksplice, Oracle VM's Secure Live Migration feature helps to preserve application continuity while maintaining security. Secure Live Migration allows administrators to move a virtual server and its workload to another physical machine while applications continue to run. The migration traffic is encrypted by default to protect sensitive data from potential exploitation. This capability allows maintenance to be performed on the first machine, its VMs, or the application or operating system software within the VM. Secure Live Migration can be used to simplify hardware upgrades, load balancing, or resource changes—allowing the VM to be moved securely to a server in the pool with more physical memory, more CPU capacity, or a better I/O subsystem.

Fast Standardized Application Deployments

Oracle PDIT administrators rely heavily on Oracle VM Templates to automate the provisioning of production-ready application environments. Using Oracle VM Templates, administrators can quickly and consistently build pre-optimized, pre-patched guest VMs and fully configured application stacks based on best practices and standards. Oracle supplies validated templates for Oracle Database 11*g* or 12*c* configurations as well as ones that deploy full Oracle application stacks with Oracle Fusion Middleware, Oracle E-Business Suite, or Oracle's PeopleSoft, J.D. Edwards EnterpriseOne, or Siebel CRM products. (The complete list of validated templates is available at www.oracle.com/technetwork/server-storage/vm/overview/templates-101937.html.)

Oracle VM Templates accelerate time-to-production for new applications. After downloading and importing an Oracle VM Template, for example, a single instance database can be available in as little as 5 or 6 minutes. A fully configured, production-ready, two-node Oracle RAC cluster can be built in less than 30 minutes. And administrators can construct a complete Oracle E-Business Suite 2-node cluster in less than three hours—significantly faster than building VMs and application stacks manually with less risk of configuration mistakes.

Several Oracle VM Templates are the direct result of Oracle PDIT's collaboration with Oracle software product development teams—for example, the templates for Oracle Fusion Middleware and Oracle's PeopleSoft software. Oracle PDIT engineers work closely with Oracle software groups to create and validate fully configured base VMs and application images that are suitable for deployment. Oracle PDIT extends customer-ready templates to meet its own internal Oracle IT requirements (adding authentication hooks, for example) and conducts its own additional quality assurance testing. Oracle PDIT then uses these validated templates to provision VMs and Oracle applications to meet demand.

Like most IT organizations today, Oracle PDIT is extending its application deployment model to encompass cloud services, further increasing agility for application and VM deployments. Towards this end Oracle PDIT actively collaborates with engineers that contribute to Oracle OpenStack as well as with the development teams working on Oracle Linux and Oracle VM. Adopters of this OpenStack cloud computing technology can easily implement Oracle OpenStack for Oracle Linux in Oracle VM virtual environments, which is exactly what Oracle PDIT is doing. The white paper Oracle OpenStack for Oracle Linux: Installation and User's Guide provides guidelines that can help IT organizations get started building a multi-node OpenStack deployment using Oracle VM and Oracle Linux.

Virtualize Oracle Applications with Confidence

Oracle PDIT's use of Oracle VM provides an excellent proof point that underscores the stability of this virtualization technology for large-scale Oracle application workloads. Each Oracle software development group performs their own series of validation tests on Oracle VM with every new release. In addition to these tests, Oracle PDIT certifies applications on Oracle VM in its own production-level quality engineering (QE) environments. The focus of the QE effort goes beyond exercising application functionality—rather, Oracle PDIT validates how applications perform when virtualized and how they scale under real payloads. As a result of this stress testing, Oracle PDIT provides valuable feedback to Oracle development groups including ideas for enhancements as well as quality

improvements. When customers deploy Oracle software applications into production on Oracle VM, they can do so knowing that Oracle's own internal IT organization has also extensively validated the same applications on Oracle VM.

Oracle VM in Oracle Managed Cloud Services

Within Oracle PDIT, Oracle Managed Cloud Services is a revenue-generating business that supplies Oracle applications as customer-facing private cloud services. Oracle Managed Cloud Services deploys Oracle Database, Oracle Fusion Middleware, and Oracle applications (such as Oracle E-Business Suite and Oracle's PeopleSoft, JD Edwards EnterpriseOne, and Siebel CRM) as cloud services to more than 5.5 million end-users. These applications are almost entirely virtualized on Oracle VM. The organization manages over 15,000 virtual and physical servers configured primarily with Oracle VM and Oracle Linux. Oracle Managed Cloud Services deploys Oracle VM software because it provides the availability, performance, scalability, and security needed to support business-critical Oracle applications to its cloud service customers.

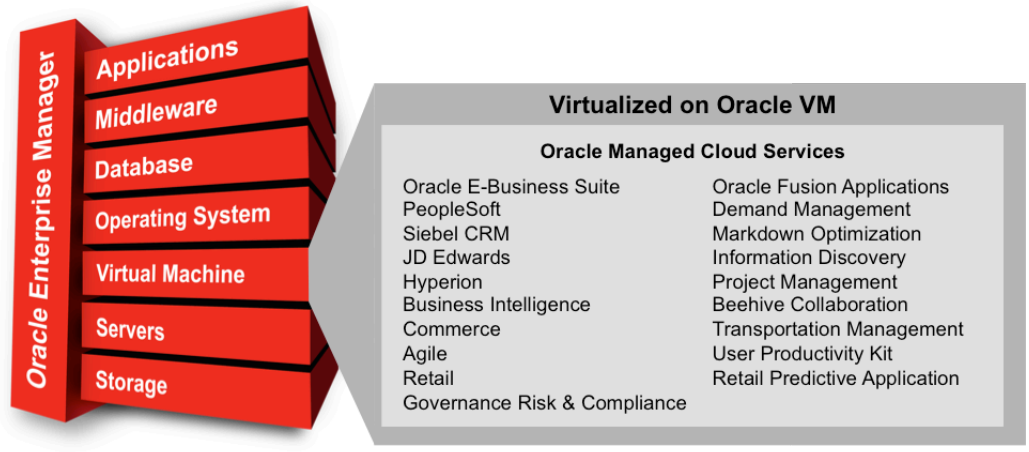

Figure 1. Oracle Managed Cloud Services provides Oracle applications as cloud services to more than 5.5 million users.

Oracle Managed Cloud Services deploys Oracle applications on end-to-end Oracle stack (Figure 1). Doing so poses an advantage because it increases the stability and reliability of application delivery. Deploying on an Oracle infrastructure is also an advantage from a customer's perspective—customers know that if there's a problem, then it's an Oracle problem that will be identified and resolved quickly since the organization can tap into internal resources and expertise 24x7.

Oracle Managed Cloud Services was an early adopter of virtualization technology, starting with deployments based on the Xen hypervisor in 2005. The group implemented the first formal releases of Oracle VM in 2006 and 2007. At that time, the organization thoroughly investigated the security and performance implications of using virtual rather than physical servers to host workloads for multiple tenants. Optimizations to the Xen hypervisor and Oracle VM technology (including virtualized device drivers) through the years have resulted in virtualized performance comparable to physical server deployments. Enhancements over time (such as the addition of sophisticated management tools) make Oracle VM the ideal choice today for virtualizing enterprise applications. Since 2012, Oracle Managed Cloud Services has standardized on Oracle VM—it is the default environment for all server deployments in its operations.

In selecting Oracle VM as its enterprise standard, Oracle Managed Cloud Services extensively tested and evaluated the technology against rigorous design requirements:

- **Security**. Oracle Managed Cloud Services conducted (and continues to perform) formal review processes with rigorous intrusion testing. By configuring virtual servers, administrators can allocate separate machines for database, application, and web service functions more cost-effectively than physical machines. In the event of a server compromise, using separate VMs limits exposure, reducing any impact on application availability.
- **Isolation**. Since Oracle Managed Cloud Services provisions services to multiple tenants, isolating one customer's processes, data, and network resources from another's is a crucial requirement. Before standardizing on virtualization with Oracle VM, Oracle Managed Cloud Services performed extensive testing to validate and optimize virtual environments for multi-tenancy. Adding VLANs to Oracle VM virtual servers (in addition to configuring other mechanisms such as iptables and perimeter firewalls) helps the organization implement strict isolation between customer workloads.
- **Stability**. Oracle Managed Cloud Services values the reliability that Oracle VM and Oracle Linux bring to the delivery of Oracle application workloads. These proven components help maintain continuously running production services that contribute to revenue generation. Capabilities such as Ksplice and Live Migration increase uptime, allowing the group to meet challenging service level agreements for its customers.
- **Scalability**. Oracle Managed Cloud Services requires virtualization technology that can scale to support potentially large-scale databases, huge user populations, and many virtual machines. Oracle VM has proven to be highly scalable—with Oracle VM Release 3 each guest VM can support up to128 virtual CPUs (vCPUs). While Oracle Managed Cloud Services configures most VMs with 4 to 32 vCPUs and 16 to 128GB of RAM, extremely large VMs are sometimes needed to support table spaces for large databases. Some VMs require 100 or more vCPUs and multiple terabytes of memory. Oracle VM offers the scalability needed to scale beyond typical configurations (even permitting virtualization of an entire machine's resources as a single VM), satisfying an important design goal for delivering large-scale enterprise workloads. Oracle VM also offers scalability with respect to the number of VMs that it can support. While the number of VMs deployed by Oracle Managed Cloud Services is rapidly approaching 20,000, the group's design goal is 100,000 VMs—a number that the Oracle VM release can support today if necessary. IT managers in the Oracle Managed Cloud Services group value the headroom that the Oracle VM software offers, especially since workload requirements are always on the rise.
- **Performance**. Virtualization software must provide near-native performance to support CPU- and I/O-intensive Oracle software workloads. For Oracle Managed Cloud Services, the networking stack must support 10 Gigabit Ethernet speeds and scale beyond that point in the near future. As Oracle VM has evolved, Oracle engineers have worked diligently to identify bottlenecks and optimize the virtualized performance of Oracle applications. As a result, Oracle VM features paravirtualized device drivers today that achieve comparable performance to physical machines.
- **Disaster containment.** To meet requirements for containment, Oracle Managed Cloud Services creates management "zones" that simplify management and compartmentalize data center resources and VMs. As shown in Figure 2, Oracle Managed Cloud Services defines a zone with a single Oracle VM Manager instance and four Oracle VM server pools. Each server pool consists of 12 physical servers and redundant storage. (Depending on application requirements, servers in a pool can share NAS storage or pools within the zone can access shared SAN storage.) The zone also houses dedicated networking equipment such as 10GigE switches, routers, load balancers, and firewalls. For disaster recovery purposes, Oracle Managed Cloud Services has three disaster recovery sites in addition to four primary data centers based on this architecture.

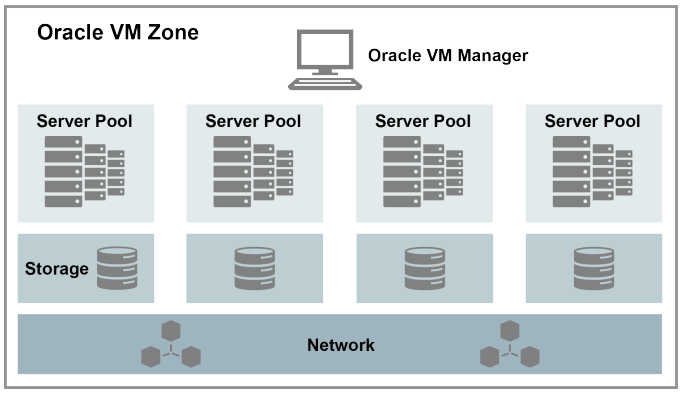

Figure 2. An Oracle Managed Cloud Services management zone.

» **Manageability.** Oracle Managed Cloud Services takes advantage of Oracle VM Manager, the easy-to-use, browser-based interface provided with Oracle VM. Management capabilities include real-time monitoring of Oracle VM Server utilization (for both SPARC and x86 servers), with the ability to add resources dynamically, rebalance the server pool, and migrate VMs to less heavily loaded servers.

To achieve a global view across multiple data centers (Figure 3), Oracle Managed Cloud Services uses Oracle Enterprise Manager. The base product of Oracle Enterprise Manager Cloud Control 12*c* includes functionality that is free of charge for an Oracle VM deployment under a support subscription (included is the ability to deploy Oracle VM server software to bare-metal servers and create guest VMs; see the description of Oracle Enterprise Manager base functionality at docs.oracle.com/cd/E24628_01/doc.121/e24474/toc.htm). Oracle Enterprise Manager encompasses and extends the capabilities of Oracle VM Manager, supplying a comprehensive interface for managing Oracle hardware, firmware, virtual systems, and operating system instances, including OS patching and updates. Other packages in the Oracle Enterprise Manager family (such as Cloud Management Packs for Oracle Database or Oracle Middleware) give administrators fine-grained control of Oracle Databases and Oracle applications. These tools allow multiple Oracle Managed Cloud Services administrators to control application environments and infrastructure resources across the different sites. Roles defined within Oracle Enterprise Manager determine the management targets that each administrator can see and control.

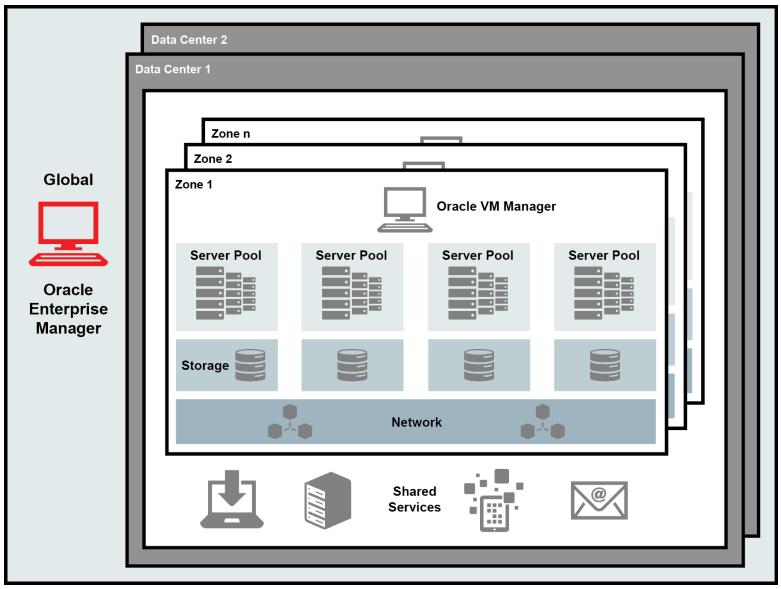

Figure 3. Oracle Managed Cloud Services deployment across global data centers.

- **Cost**. The Oracle Managed Cloud Services organization finds that an approach of using standardized building blocks helps to control and lower costs. Defining certified configurations for each application (similar to the approach of using Oracle VM templates) and re-using them across deployments fosters automation. Standardization reduces errors and enables repeatable processes that minimize labor costs. Sharing infrastructure where possible and isolating application workloads using Oracle VM virtual servers also helps to reduce costs. Oracle Managed Cloud Services uses Oracle VM virtualization to partition CPU cores, reducing software costs while complying with Oracle software licensing policies. Partitioning helps to decrease software costs and enable savings that can be ultimately passed on to the group's customers.

Using Oracle VM to define self-contained zones with server pools, storage, and networking, Oracle Managed Cloud Services creates an optimized and standardized architecture for delivering Oracle applications as cloud services to tenants. Oracle VM is a core component for this revenue-generating business because it delivers the agility and availability needed to support continuous operations and high service levels.

Oracle VM in Oracle Engineered Systems

Oracle PDIT and Oracle Managed Cloud Services deploy application workloads on Oracle engineered systems (as well as on x86 and SPARC general-purpose servers). Oracle engineered systems are purpose-built systems based on Oracle hardware and software components that are fully integrated and optimized. Because they are pre-configured to meet a particular purpose, they lower the cost and complexity of implementing IT infrastructure, speeding time-to-production for both internal and external Oracle customers. Oracle VM is a core component in several engineered systems because it brings flexibility, performance, and reliability to virtualized deployments of Oracle applications.

These Oracle engineered systems feature Oracle VM:

- Oracle Database Appliance. This is an entry-level 2-node database appliance that pre-integrates Oracle RAC, Oracle Linux, Oracle VM, x86 servers, storage, and networking components. It is a fully configured appliance that delivers highly available database services for a range of online transaction processing (OLTP) and data warehousing applications.
- Oracle Exalogic Elastic Cloud. This Oracle engineered system integrates compute, network, and storage components with Oracle VM, providing a high-performance infrastructure on which to deploy Oracle business applications, Oracle Fusion Middleware, or other software. Oracle VM is tightly integrated with the I/O backplane using a technique called Single-Root I/O Virtualization (SR-IOV). SR-IOV allows the same InfiniBand I/O adapter to be shared by up to 63 virtual machines, eliminating overhead and delivering exceptional application performance.
- Oracle's Virtual Compute Appliance. This appliance is a turnkey converged infrastructure solution that integrates Oracle VM with compute, network, and storage resources in a software-defined fabric. It supplies an infrastructure that can scale from 2 to 25 compute nodes per rack. The high-performance, low-latency Oracle Fabric Interconnect with Oracle Software Defined Networking (SDN)—two products in the Oracle Virtual Networking family—detect available compute nodes and automatically configure the appliance and storage networks.

Oracle VM has an extensive product quality assurance process that includes testing of all Oracle VM Manager interface capabilities as well as performance and scalability testing. Development teams for Oracle engineered systems conduct their own additional Quality Engineering (QE) processes, validating each engineered system and the Oracle VM functionality within each system. The team that develops Oracle's Virtual Compute Appliance, for example, incorporates a fully qualified release of Oracle VM, adding optimizations to support larger scale configurations and tuning Oracle VM Server x86_64 kernel settings to improve I/O performance in the Virtual Compute Appliance configuration; they then validate integration between all of the appliance components including Oracle VM. As Julie Trask, the Senior Director for the Oracle VM and Virtual Compute Appliance QE teams, points out, "Our goal is to test the fully integrated Virtual Compute Appliance stack of which Oracle VM is a part. We rely on the reliability and stability of the Oracle VM release that is already incorporated into the appliance." QE testing for

the appliance focuses on validating Oracle VM integration points such as VM Secure Live Migration, network performance of automatically configured appliance VLANs, and new feature testing (such as support for fiber channel and the ability for guests to boot from fiber channel-attached disks). The Virtual Compute Appliance QE team provides valuable feedback for the base Oracle VM product team. Product quality, performance issues, and desired enhancements are fed back into the Oracle VM development group, further enhancing the quality and stability of the Oracle VM software.

The Virtual Compute Appliance is an engineered system that makes use of all Oracle VM features: the Oracle Server for x86, Oracle VM Manager, and Oracle VM Templates. The appliance preconfigures duplicate Oracle VM management nodes, providing redundancy and failover for Oracle VM Manager. The quality engineering team is heavily dependent on Oracle VM Templates to stand up application stacks for testing. “Templates are a huge part of our environment and we use them regularly as a part of our Virtual Compute Appliance testing,” Trask commented. “Our standard procedures for efficiently building test environments of varying sizes rely heavily on importing templates and cloning the resulting virtual machines. This approach is especially helpful when we stand up large-scale configurations.”

Templates allow administrators to create ready-to-run VMs on the appliance in minutes. As an example, the webcast “Virtualization and Cloud Made Simple and Easy with Oracle's Latest Engineered System” shows how a DBA can have a production-ready Oracle Database up and running in a VM within an hour of power-on.

Conclusion

Oracle VM is a mature and stable virtualization technology that is enterprise-proven both internally in Oracle’s IT operations and in multiple engineered systems. Based on Oracle PDIT’s experience with Oracle VM and the stability it provides, May Yuan (a Senior Director for Oracle PDIT’s Architecture and Performance Team) has this message for other IT managers considering Oracle VM for Oracle application deployments:

> *“If an enterprise runs Oracle software, it should be deployed on Oracle VM. There is such a large base of Oracle VM within Oracle itself that anything a customer might experience we’ve already encountered. The environment is extremely stable and highly available.”*

IT organizations that deploy Oracle applications on Oracle VM gain the advantage of a single vendor that has extensively integrated and tested the technology with the entire Oracle stack. In today’s virtualized IT environments, problems can occur at any level of the compute stack, and it is often a difficult process to determine the root cause. Being able to turn to Oracle for fast resolution (rather than relying on multiple suppliers) is a tremendous benefit of running Oracle applications on Oracle VM.

The cost model to deploy Oracle VM is an added incentive—customers can freely download the software, which includes management tools (both Oracle VM Manager and Oracle Enterprise Manager). Customers pay only for enterprise support. This means that the Oracle VM software can be deployed at no charge on development and test systems that don’t explicitly require support contracts.

You can achieve the same advantages—reliability, scalability, performance, and easy deployment and manageability—that are enjoyed today by Oracle‘s internal IT organizations that run Oracle applications on Oracle VM. Get started with Oracle VM by downloading the software at edelivery.oracle.com/oraclevm. Contact your Oracle representative or visit www.oracle.com/virtualization (or the references below) to learn more.

References

TABLE 1. RESOURCES FOR MORE INFORMATION	
WEB RESOURCES	**WEB URL**
Oracle VM Download	edelivery.oracle.com/oraclevm
Oracle VM E-Book	oracle.com.edgesuite.net/ebook/ovm/index.html
Oracle VM Home Page	www.oracle.com/us/technologies/virtualization/oraclevm/overview/index.html
Oracle VM Templates	www.oracle.com/technetwork/server-storage/vm/overview/templates-101937.html
Oracle VM Cost Calculator	www.oracle.com/us/media/calculator/vm/index.html
WEBCASTS	**WEB URL**
Top 5 Reasons why Oracle VM is Best for Oracle Database	event.on24.com/r.htm?e=725350&s=1&k=1512E332202610FE9518AB8B01354C6A&partnerref=OVMOnDemand
"Oracle VM Templates: Best Practices for Rapid Oracle Database Deployment"	www.oracle.com/technetwork/server-storage/vm/database-templates-12c-11gr2-1972804.html
"Oracle VM: Design Considerations for Enterprise-Scale Deployment"	http://event.on24.com/r.htm?e=780610&s=1&k=FCAE97278286B15C146070D9AB548986&partnerref=OVM-MCSwebcast_ecom
WHITE PAPERS	**WEB URL**
Why Oracle VM is the Best Platform for Deploying Oracle Database (PDF)	www.oracle.com/us/technologies/virtualization/oracle-vm-for-oracle-database-2155841.pdf
Application-Driven Virtualization (PDF)	www.oracle.com/us/technologies/virtualization/ovm3-app-driven-459334.pdf
Oracle VM - Built for Virtualizing Enterprise Applications (PDF)	www.oracle.com/us/technologies/virtualization/oracle-vm-wp-2349820.pdf

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