An Oracle White Paper
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Creating a Self-Service Dev/Test Cloud

A Case Study From Oracle Product Development IT

ORACLE

Executive Overview

The cloud-computing phenomenon has quickly progressed from buzzword to actuality as organizations deploy private clouds and utilize public cloud services. One popular use-case for cloud computing is software development and testing, a resource-intensive activity with continually fluctuating workloads. This white paper describes Oracle's experience creating and using a self-service private Infrastructure-as-a-Service (IaaS) cloud for its large development organization.

Oracle has thousands of developers for its core software products, which include Oracle Database, Oracle Fusion Middleware, and the Oracle Applications. Every day Oracle's software development professionals run a large number of tests and execute programs to ensure that all Oracle software products meet the business and technical requirements, work as expected and can be implemented with the same characteristics on all supported platforms.

Previously all of Oracle's development teams had their own labs for software build, test and execution. Oracle decided to build a shared private cloud to bring greater efficiency and economies of scale to this worldwide development effort. Today, instead of vying for a small number of local compute resources, each development team accesses a centralized pool of server and storage resources, housed in the Oracle datacenter in Austin, Texas and delivered as a service to Oracle developers worldwide on demand. Having a larger, shared pool of resources rather than many small ones allows Oracle to address utilization more intelligently. Developers are able to access the hardware resources through a self-service user interface in a fraction of the time it formerly required, improving productivity and accelerating product development cycle time. Through a customized queuing system, managers can prioritize the tasks and projects that are most important, allocate IT resources to meet tight deadlines and set global priorities based on executive strategy.

In addition to enforcing overall engineering objectives and maximizing available hardware resources, Oracle Product Development IT finds it much easier to keep each server current with the proper version of the operating system, the necessary language compilers, and all essential developer tools and utilities. Oracle Product Development IT has fewer sites to track, and system administrators can take advantage of economies of scale for tuning, configuration and updates. Having a centralized pool of servers and storage devices also makes it easier to produce reports about who uses which resources, for how long, and for what purpose. Most importantly, Oracle has more flexibility to balance workloads and allocate resources to the labs and product development teams that need them most at any given point in time. Hardware utilization is maximized, developer wait time is minimized, and configuration issues are dramatically simplified.

"Oracle's Dev/Test cloud infrastructure allows the Oracle Fusion Middleware teams to automate essential development and test workloads across all Oracle Fusion Middleware releases, giving us tremendous leverage to improve software development efficiency and quality."

Naggi Asmar, Vice President, Oracle Fusion Middleware Development

Sizing up the Problem

Maximizing IT resources is a common problem facing many large companies, especially those with information-intensive business models such as financial services, telecommunications, high technology and manufacturing. Priorities and workloads fluctuate continually—from team to team, department to department, and project to project. Some groups need more resources at certain times while others need less.

For example, in the final weeks before the release of a new version of Oracle Database, Oracle's database development team must be able to run tens of thousands of tests to ensure a stable software release. Previously, Oracle had to size each lab's server farm to meet its demands during these peak times, which led to lots of unused capacity. Another problem was the costs and complications of managing computers and storage arrays at many different labs. In order to ensure compatibility of Oracle software with various computer platforms, each lab had to maintain a wide variety of test environments. For example, some development servers run Oracle Linux version 5, while others run Oracle Linux version 6. There are many additional configurations for Oracle Solaris and Microsoft Windows environments. Developers need the flexibility to test Oracle software within each environment.

In short, Oracle's Global IT department had to maintain a very diverse infrastructure in numerous places, which entailed lots of duplicate effort to make sure that each lab had the proper versions and updates for each server and storage array. Planning for expansion and allocating IT dollars was also very complicated, since Oracle's purchasing department had to have a separate discussion with each team.

Building the Dev/Test Cloud

To resolve these issues and consolidate its sprawling, under-utilized infrastructure, Oracle Software Engineering Group decided to build a private IaaS cloud for Dev/Test. First, Oracle placed all of its resources into a common pool of server and storage capacity in Oracle's Austin Data Center. Oracle then created an application that gave developers and QA specialists self-service access to these resources with mechanisms to control user privileges, manage job priorities, automatically find appropriate resources, schedule jobs, store results and enable

monitoring and reporting. This new IaaS cloud for Dev/Test was rapidly adopted, and usage expanded to multiple product development groups within Oracle.

The Oracle Dev/Test cloud currently contains more than 2,600 physical servers and 6,000 virtual servers, which host the following computing environments:

- LINUX.X64 (Linux 64 bit OS)
- LINUX (Linux 32 bit OS)
- WINDOWS (Windows 64 bit OS)
- WINDOWS.X64 (Windows 64 bit OS)
- SOLARIS.SPARC64 (Solaris SPARC)
- SOLARIS.X64 (Solaris Intel)
- HPUX.PARISC64 (HP PA-RISC)
- AIX.PPC64 (IBM AIX)
- LINUX.PPC64 (IBM PowerPC)
- LINUX.ZSERIES64 (IBM zSeries)

Within each environment, Oracle Product Development IT installed various operating systems. For instance, within the 64-bit Windows platform there are servers running Windows 2008R2 OS, Windows 2003 Server OS, and so forth. For Linux X64, there are servers running Oracle Linux 5, Oracle Linux 6, and so on. All told, there are more than 6,500 servers available across these environments. Most of them are virtual servers running Oracle VM. Some servers are clustered. Others are only available as single servers.

Leveraging Economies of Scale with Virtual Servers

Virtualization is a term that refers to the abstraction of IT resources from the consumer of those resources, such that computing workloads are not dependent on the underlying physical infrastructure. Virtualization enables a single physical computer to be shared by multiple virtual servers or operating environments. Each of the virtual environments is referred to as a virtual machine—a software implementation of a computer that executes programs like a physical machine. Virtual machines appear to the operating system as independent systems but are actually simulated by the host computer system.

Virtualization, in effect, decouples software from the hardware on which it runs. As a result, virtualization provides a method for sharing and managing physical systems and resources. Oracle Product Development IT applied these concepts to the Dev/Test cloud to reduce overall costs by consolidating hardware and software resources. By isolating the software from the hardware, virtualization permits rapid, error-free software deployment with little or no physical

"Our usage of the Dev/Test cloud has not only grown in size it has also matured to the point where we can on a daily basis integrate the work of all the Oracle Fusion Middleware and Oracle Fusion Apps developers. What used to take six weeks through a laborious and error prone process is now done reliably many times each day. Our integration across the stack is our single biggest differentiator and the Dev/Test cloud is an indispensable tool to achieve it."

Christophe Job, Vice President of Fusion Middleware Development

hardware provisioning, thus dramatically reducing the time necessary to get applications up and running.

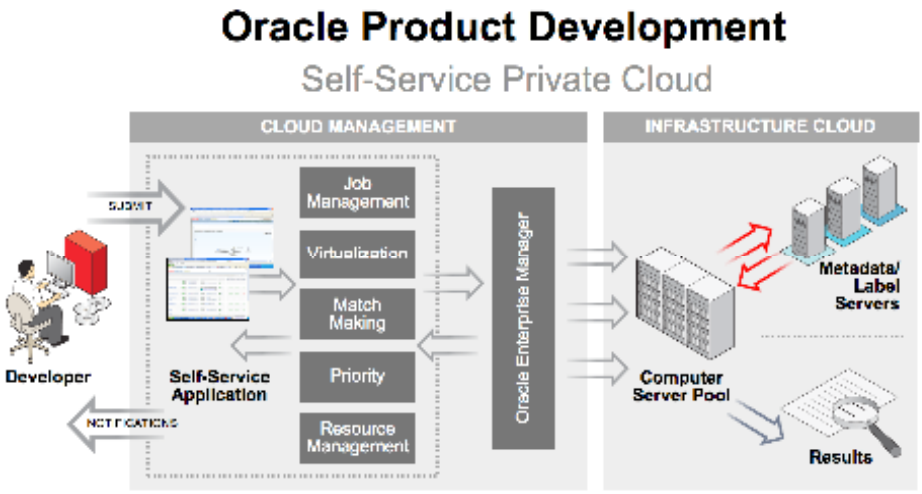
Oracle VM is a highly efficient virtualization solution for both x86 and SPARC architectures, making it possible to virtualize a heterogeneous hardware environment. Oracle VM includes a browser-based management console, permitting users to create and manage virtual machines that exist on the same physical server but that behave independently, with each VM having its own virtual CPUs, network interfaces, storage capacity, and operating system.

Creating a Queuing System

An important attribute of the cloud model is on-demand self-service, which permits users to provision computing capabilities without interacting with an IT system administrator. To facilitate this self-service approach for Oracle product developers, Oracle Software Engineering Group created a job queuing system that automates the scheduling, submission and prioritization of testing jobs to the Dev/Test cloud. For example, during a typical development day, the database development team submits over 6,000 tests for the daily build. Oracle's automated queuing system manages all of the corresponding builds and test executions in an orderly fashion. Formerly it used to take several days to manage a similar level of testing activity.

While developing the queuing system Oracle devised APIs to automate the submission of test and build procedures to the Dev/Test cloud. It's very easy for developers to interact with specific types of servers and quickly obtain results. Users simply specify the desired platform, OS and other variables as they submit each job.

For example, a developer might want to test a new version of Oracle Database 11*g*R2 on a Sun SPARC server running Solaris 11 with 4 GB of memory. He simply puts it in the appropriate queue, specifies how many times he wants it to run, and it will be automatically scheduled and executed. It's all "hands free" for the developers—they simply submit requests and obtain their results, as illustrated in the diagram below.



System administrators use Oracle Identity Manager to authorize users, authenticate their activities and provision resources among each team. As new developers and QA specialists are provisioned they are assigned an account, a workstation, and a password that permits them to submit jobs to the queue. Oracle Identity and Access Management Suite provides an ideal facility for managing access and security to this global user base.

Oracle Access Manager allows developers and QA specialists to log in once and gain access to all of the cloud resources, with an identity management and access control system that is shared by all development projects. The result is centralized and automated single sign-on (SSO) for developers at each Oracle lab throughout the enterprise. Oracle Identity Manager simplifies role and user administration by automating the process of adding, updating, and deleting user accounts and attribute-level entitlements across these cloud resources.

All of these Dev/Test activities are prioritized and budgeted based on Service Level Agreements (SLAs) that ensure that the total amount of computing resources satisfies the needs of the worldwide development organization. Oracle Product Development IT provides reports to management that break down how cloud resources are utilized by the various teams. Managers use these reports during each budgeting cycle to determine the needs, priorities and resource allocations for the following fiscal year. These percentages are especially important during peak times when there may be contention for resources since they dictate the maximum allocations available for each project and lab.

"Oracle Dev/Test cloud dramatically increased developer productivity especially for products with lots of code that need substantial amounts of integration testing. The Dev/Test cloud has allowed us to require more stringent code-merge criteria on the main database code line with the result that we are rarely unable to complete a daily database/build and long regress cycle and are able to do full scale system testing at any point during the development cycle."

Carol Sexton, Vice President of Database Development

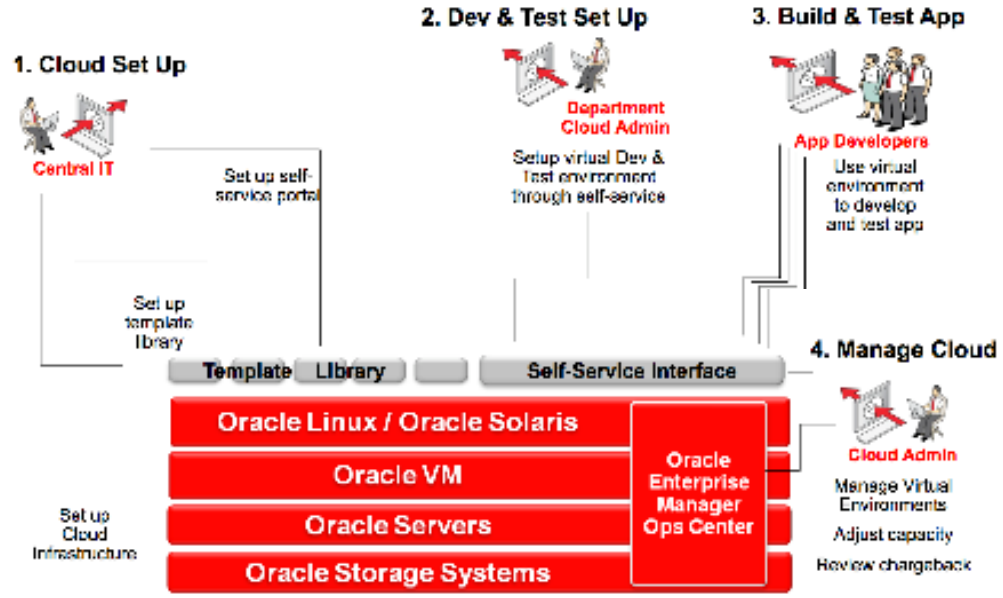
Cloud Usage

The Oracle Dev/Test cloud has been operating continuously since 2004. It has evolved steadily over time. For example, virtualization was introduced in 2009. Developers made the transition to the self-service environment almost immediately, mainly because access and job submission is so seamless and the cloud resources are readily available. Today more than 4,000 developers use the Dev/Test cloud to process over 70,000 jobs per day. Utilization rates for cloud servers average 80 percent, seven days per week, and can reach 90 percent during peak times. In many organizations without a Dev/Test cloud, utilization rates are often in the range of 5 to 10 percent. It only takes four or five administrators to manage this highly automated, self-service environment.

Software developers and QA specialists simply execute software test, build and execution procedures based on their plans and test documents, then report any errors to the development team. They can pick a precise platform to execute each particular test. Some computers are clustered together to run Oracle Real Application Clusters (RAC) in configurations of 2, 3, 4 and 12 nodes, permitting testing of Oracle software in a clustered database environment with shared storage arrays. Developers can stay focused on their individual responsibilities, without spending undue effort on resource availability, scheduling, or prioritization issues. Those decisions are made by senior managers in Oracle's global development organization, based on continually shifting corporate priorities.

"We have adopted a cloud based approach for all of our building, testing and other work tasks. We can submit a 'job' and there is automatic resource allocation done across thousands of machines based on availability. Jobs can be parallelized, queued etc. and this is how we support true continuous integration across more than 50 code lines and 3,000 Fusion apps developers."

Mikael Ottosson, VP Fusion Middleware and Fusion Apps Development



For example, about 45,000 jobs are submitted to the Linux X64 cluster each day, which spawns about 55,000 hours of processing time. All developers and QA specialists are more productive. Basic functionality tests that used to take 20+ hours on a private workstation now take about six hours when submitted to the cloud, a time savings of more than 70%.

Enabling Full Lifecycle Maintenance

Private clouds require sophisticated management tools to contend with multiple servers, large data sets and virtualized IT services. Oracle Product Development IT uses Oracle Enterprise Manager to manage all cloud resources from application to disk. This comprehensive administrator console includes specialized management and monitoring capabilities for the entire Oracle stack, with a unique lifecycle approach to cloud management. Oracle Enterprise Manager interfaces with the Oracle VM Management Pack, enabling administrators to manage the virtual machines, the operating systems and the software running inside the virtual machines from a single interface. It simplifies the creation and configuration of virtual server pools, as well as the registration of virtual machines so that they can be centrally monitored and managed. Once these

servers are online, cloud administrators use Oracle Enterprise Manager to balance IT activities across resource pools and to automatically reduce or eliminate outages associated with server downtime.

System administrators also use Oracle Enterprise Manager to set up cloud policies, deploy software applications, automate patching activities, scale the infrastructure, and monitor the hardware, operating systems, and Dev/Test applications. It is a unified tool for managing and monitoring all of the computers, storage devices and other IT resources, as well as for visualizing activities on each node to verify that the cloud is correctly configured and upholding agreed upon service levels.

Summing up the Benefits

Cloud computing is a model for enabling convenient, on-demand network access to a shared pool of configurable computing resources that can be rapidly provisioned and released with minimal management effort or service provider interaction. Private cloud technology has become progressively more viable as wide area networks get faster, bandwidth becomes more plentiful, and virtual machine software matures, bolstered by advanced methods for cloud maintenance, access and authentication. The main benefits of cloud computing are speed and cost. It is easy to make adjustments to the overall computing capacity, thanks to the cloud's shared and elastically scalable architecture.

Oracle has validated these cost and performance benefits with its private IaaS cloud for its internal development organization. Since Oracle's private Dev/Test cloud went live, developer productivity has steadily increased. Each team can run its tests more efficiently, resulting in higher quality code and more timely software releases. Previously developers used a handful of local servers for these activities, and they often had to fine-tune the configurations between tests. Now they have a bank of thousands of virtual machines at their disposal, which provides enough capacity to keep even unusual configurations online all the time. Developers can conduct final testing and QA more rapidly and they have an easier time submitting all necessary tests before finalizing a code change. Project managers get more rapid feedback on how each initiative is progressing, keeping Oracle product releases on schedule. In many cases, complex testing cycles now take hours instead of days. For Oracle customers, this translates into more stable code and higher quality software products.

Having a shared Dev/Test cloud for these global development activities is faster, more reliable and scalable than having a number of small server farms. If a computer goes down, its pro-rata impact is much less significant, since it only represents a small fraction of the processing power of the entire Dev/Test cloud. In addition, having all server and storage resources co-located in a private cloud leads to greater economies of scale and allows administrators to minimize the number of unusual configurations and non-standard setups. Oracle Product Development IT can

provide better performance against application SLAs across the enterprise without having to provision each application individually for its own peak workload.

In addition, the Dev/Test cloud enables managers to align resources with projects based on corporate priorities to ensure that high-demand resources are used by the right groups at the right time. Requests are automatically routed to the right machines with the correct priority based on the importance of each project. Oracle Enterprise Manager simplifies the entire maintenance lifecycle, from cloud setup to testing, deployment, and change management.

Now that Oracle's development organization has a centrally managed pool of computers, it is easier for Global IT to keep them configured, updated and online. Oracle's private cloud supplies a flexible pool of shared capacity that is easy to upgrade, manage and expand, with one unified budget rather than ten.

Conclusion: Try This at Home

For any large company that develops in-house software, efficiently allocating computing resources is an ongoing challenge. Software development and test is an obvious use-case for self-service IaaS clouds, which dramatically improve hardware utilization rates, developer productivity and development time-to-market. Centralizing development resources into a private, self-service cloud also minimizes maintenance and administration workload.

Oracle customers can realize many of these same advantages as they create private clouds for Dev/Test and other domains. The first step is to move from a silo-ed IT environment to a consolidated, virtualized environment. Instead of having a dedicated, rigid, physical structure for each application or domain, virtual environments facilitate shared services and dynamic resource provisioning. Oracle VM makes it easy to consolidate servers, rapidly deploy software, recover quickly from system failures, and match resource capacity to workloads.

Oracle delivers all the necessary building blocks to create a private cloud environment and maximize the return on investment (ROI). Oracle Sun servers, storage and network fabric along with Oracle Linux, Oracle Solaris, and Oracle VM virtualization technologies can enable these Infrastructure as a Service clouds. Oracle Enterprise Manager, with its rich and scalable management framework, provides a unified view of the complete cloud stack and helps unlock the full value of cloud computing—agility, elasticity and reduced IT costs. These and other Oracle technologies can facilitate the transformation to cloud computing.

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